Sky and TELESCOPE

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Gran Sasso station

Vol. X, No. 11
SEPTEMBER, 1951
Whole Number 119

In This Issue:

Gran Sasso Observatory
Hydrogen Showers — I
Stars for September
American Astronomers Report
The Limit of Visibility of Eclipses

LETTERS

Sir:

In numerous books and observation manuals, and often in everyday discussions on astronomy, the very small telescope is nearly always spoken of with consideration, and justly so. It has been said time and again that there are a myriad of beautiful views in the heavens awaiting the small glass. Such a statement is true, and can readily be verified by anyone with the necessary piece of equipment.

It was the writer's desire to discover just what an extremely small glass would reveal that prompted him to construct an instrument for himself last summer. The telescope pictured here was made entirely from available parts, and in less than one hour's time. The objective was a two-element achromatic 35-mm. projection lens, with a diameter of 1″ and a focal length of about 3½″. At f/3.5, the lens was not usable, and it was consequently diaphragmed down to ½″, and therefore worked at f/7.

The ocular was a 1/6″ focus single biconvex lens mounted in a standard 1¼″ tube. The resulting telescope approximated a magnification of 20x, or 40x per inch of aperture. The definition was satisfactory at the center and poor at the edges—a result due to the type of ocular used. The assembly was placed on a pipe-fitting equatorial mounting and proved very steady in use.

Amazing as it may seem, this telescope outperformed my best expectations. The reader may judge this from the following representative list of objects observed.

Moon. The whole sight was pleasing, and one could see the Straight Wall unmistakably, as well as the various shadings on the floor of Plato.

Mizar. This was beautifully double, with two fine, clean-cut points of light, and at least one diffraction ring visible around the brighter. I wrote: "I have never had a more beautiful view of this double, for with this scope there are not any of the flares, spikes, etc., that one usually has with a larger instrument under inferior seeing." Despite moonlight, the 9th-magnitude companion star between Mizar and Alcor and slightly west could also be glimpsed.

Donald O'Toole's ½-inch telescope.

Albireo. This was very easy to split, and quite pretty. The colors of both stars were readily discerned.

Gamma Andromedae. The double was separated fairly easily, with sky visible between the stars.

Gamma Arietis. It was easy to see this star as double. Its separation is a mere 8″.4.

Jupiter. The four bright satellites were readily seen. On the planet itself, the disk was resolved, sharp and clean-cut. The north equatorial belt and a southern belt could be seen with some difficulty.

Theory tells us that a ½-inch aperture can reveal stars as faint as magnitude 7, and the Dawes limit indicates that double stars to nine seconds of arc can be separated with this aperture. Nevertheless, in the above observations a 9th-magnitude star could be seen, and a star of 8″.4 could be separated. Furthermore, in seeing a dark band on Jupiter which had a width of about 3″, we have proof that, in observing planetary detail, the Dawes limit for double star separation has no applicability.

DONALD O'TOOLE
114 Claremont Ave.
Vallejo, Calif.

Sir:

On page 25 of Dr. Hubble's **The Realm of the Nebulae,** we read in a footnote, "The multiplication of stellar systems led to the term 'Weltinseln'—Island Universes—used in von Humboldt's **Kosmos** (Vol. III [1850]), presumably for the first time. In the familiar English translation by Otté (1855), the word is translated literally as 'world islands' (Vol. III, 149, 150). The transition to 'island universes' is an obvious step, but the writer has not ascertained the first use of the term."

Otté's translation also appeared in England in 1851 but there, too, the expression is "world islands.",

Since "island universes" is a term in the English language, even if only a translated one, it might be of interest to amateurs to know who first precisely coined it in our tongue. One would im-

(Continued on page 271)

Sky and TELESCOPE

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VOL. X, NO. 11 — WHOLE NUMBER 119 — SEPTEMBER, 1951

CONTENTS

COVER: The Gran Sasso station of the Observatory of Rome at Monte Mario is situated at Campo Imperatore in the central Apennine Mountains. The main peak of the Gran Sasso is to the right in the background, 9,584 feet high. Photograph by Roger Leclaire, S. J., Vatican Observatory. (See page 263.)

GRAN SASSO OBSERVATORY — Massimo Cimino **263**
FOURTEEN ELEMENTARY PARTICLES OF MATTER **264**
AMERICAN ASTRONOMERS REPORT **265**
HYDROGEN SHOWERS — I — Otto Struve **267**
THE LIMIT OF VISIBILITY OF ECLIPSES — Edward M. Brooks **270**

Amateur Astronomers **266**
Books and the Sky **273**
Gleanings for ATM's **275**
Here and There with Amateurs **282**
Letters **262**
News Notes **272**
Observer's Page **278**
Planetarium Notes **280**
Stars for September **283**
Terminology Talks **271**

BACK COVER: The spiral galaxy NGC 2903, in the constellation of Leo at $9^h\ 29^m.3$, $+21°\ 43'$, photographed with the 200-inch Hale telescope. The radial velocity of this Sc-type galaxy is 350 kilometers per second away, from Mount Wilson Observatory measures. The magnitude is 10.72, according to photoelectric observations by Stebbins and Whitford. The size on an earlier photograph (Lick Observatory) is given as 12 by 5 minutes of arc. Note the many more distant galaxies in the same field of view. Mount Wilson and Palomar Observatories photograph.

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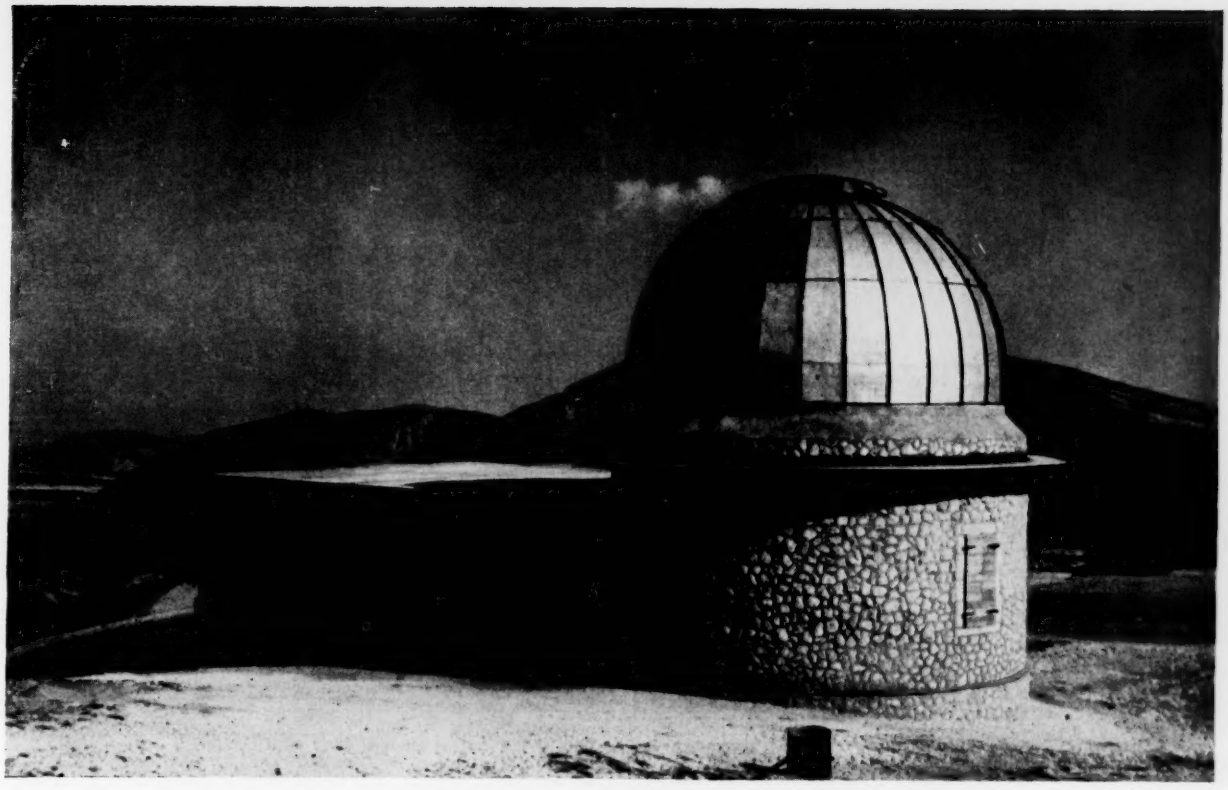


The new building of the Gran Sasso Observatory, a branch of the Observatory of Rome at Monte Mario, will house a 36-24-inch Schmidt-type telescope. It is located at Campo Imperatore, at an altitude of 2,112 meters above sea level.

GRAN SASSO OBSERVATORY

BY MASSIMO CIMINO, *Astronomical Observatory of Rome at Monte Mario*

A NEW Italian observatory, a branch of the Astronomical Observatory of Rome at Monte Mario, on a high glacial plain near the summit of Gran Sasso d'Italia in the central Apennines, is now nearly completed. The official title of the observatory is Osservatorio Astronomico di Roma, Stazione del Gran Sasso d'Italia. The observing station is not to be reserved only for systematic programs of the parent observatory; in fact, there will not even be a permanent staff in residence at the "Great Rock." Rather, the observatory facilities will be made personally available to all Italian astronomers and to astronomers from all over the world who may desire to pursue particular researches at Gran Sasso.

The city nearest the observatory is Aquila of the Abruzzi, with about 55,000 inhabitants, some 54 airline miles northeast of Rome. The locality is of relatively easy access, but along the ever-winding mountain roads an auto trip from Rome to the base of the Gran Sasso group of peaks still takes about three to four hours. When a car is not available, sporadic bus or train service brings one to Aquila, whence a 13-mile bus ride taking 20 minutes is necessary to reach the base of the mountain, already 3,625 feet above sea level. From there, two cable cars of the spectacular and thrilling funivia lift passengers 3,300 feet higher, the two stages requiring a total of about 20 minutes.

A few hundred feet from the second cable-car terminal is the Albergo Campo Imperatore, a 160-bed all-year-round hotel for tourists, especially ski enthusiasts and alpinists. This hotel is on the western edge of a fairly large glacial plain, which together with other such contiguous plains and terminal moraines has received the name of Campo Imperatore. It may be noted that after Italy joined the Western Powers during World War II, Mussolini was kept a prisoner in this same hotel, and on September 12, 1943, there occurred here one of the well-known exploits of the entire war. Hitler's crack parachute corpsmen landed at Campo Imperatore in gliders and a tiny plane. After picking up Mussolini at the nearby hotel, their leader, Col. Otto Skorzeny, managed to get the plane airborne again and so took Mussolini off to a temporary haven and safety in Germany. The soldiers on guard had figured that the hotel was accessible only to mountaineers or by way of the funivia, and before they could recover from their surprise Mussolini had been spirited away through the skies.

The observatory itself is a native-stone building a few hundred feet to the north of the hotel, on a slightly higher but gentle slope, some 7,000 feet above sea level, backed up by a rough semicircle of jagged peaks which run to nearly 10,000 feet above sea level, and which bear the collective name of Gran Sasso (see the front cover). On clear days one may see from these heights both the Adriatic and Tyrrhenian seas, and the panorama in all directions is truly breathtaking.

The observatory building consists of one main floor, plus a partly buried basement containing storage and service rooms. Facilities include comfortable living rooms for four persons, a kitchen, an office, a large laboratory and darkroom, and a workshop. The original plans, so far not executed on account of the expense involved, called for an underground passage from the observatory building to the hotel, which is both lighted and heated electrically. Part of

the two-acre property now owned by the observatory (through gifts from the Dragonetti family and the municipality of Aquila) will eventually be made into a botanic garden of mostly alpine flora.

At this altitude, of course, severe winters are to be expected, and the heavy snows last until May or June. The site is known for its bitter wintry cold and stormy blizzards, but also for not too rare nights of very calm and steady and startlingly transparent skies. Tests of transparency and seeing were made periodically on this site during the past five years by the present writer, and occasionally by Dr. Giorgio Abetti, director of the Arcetri Observatory, Dr. Attilio Colacevich, director of the Naples Observatory, Dr. Mario G. Fracastoro, of Arcetri Observatory, and Dr. Teresa Fortini, of Monte Mario Observatory.

Dr. Fortini has completed a detailed study of the very promising data. June is the worst month at Campo Imperatore, yet for this month in 1947 the author found the coefficient of atmospheric transmission to be 88 per cent of the total possible. For 1950, Dr. Fortini found this June coefficient to be 89 per cent, whereas at sea level it would be 69 per cent. She calculates that a star observed 30 degrees above the horizon at Campo Imperatore would be almost twice as bright apparently as the same star observed at sea level under the same conditions. A yearly transmission average of 90 per cent is expected.

In order to resist and keep out the fiercely blowing snows of winter, the 26-foot diameter dome has been made double-walled and of especially solid construction, the work of the Milan firm of A. Bombelli. Electric motors are, of course, provided for rotating the dome and opening the slit. Future plans call for a second and smaller dome on top of the entrance end of the building, to house a solar coronagraph. The existing dome is intended for a Schmidt-type telescope with a 36-inch mirror and 24-inch correcting plate, of focal ratio f/3, to be equipped with a four-degree objective prism. The complete optics are under construction by the Penn Optical Company of Pasadena, Calif., subject to the supervision and acceptance of D. O. Hendrix, of Mount Wilson and Palomar Observatories. Funds for acquiring these optical parts were granted by the United States to the Italian government through the European Recovery Program.

From the very beginning, Dr. Giuseppe Armellini, director of the Monte Mario Observatory, has been chiefly responsible for the establishment and financing of the Gran Sasso station. The present writer was subsequently appointed by Dr. Armellini to select and design the instrument, to plan and supervise the construction of the dome and building, and to start operations.

While on a Fulbright and Italian national research council scholarship in 1949, the writer was guest investigator at the Mount Wilson and Palomar Observatories. Through the courtesy of Jesse L. Greenstein and Bruce Rule, of California Institute of Technology, he was able to study the blueprints of the 48-72-inch Schmidt telescope at Palomar. As a matter of fact, a complete copy of the designs was donated, and has proved to be most useful in designing and constructing the Gran Sasso instrument, which is to have a fork-type mounting built in Italy.

Research work is scheduled to begin at Gran Sasso this summer, after the installation of the coronagraph, which is to be housed temporarily in the Schmidt dome. This instrument was constructed in the Arcetri shop by Dr. Colacevich.

We hope that this new observatory, so happily begun with the generous cooperation of the United States, will soon be able to make its voice heard in modern astrophysics, whose birth Italy may be said to have witnessed in the work of those pioneers of old, Father Angelo Secchi, S. J., Annibale Ricco, Lorenzo Respighi, and Pietro Tacchini.

FOURTEEN ELEMENTARY PARTICLES OF MATTER

In the April number of the *American Scientist*, Dr. Carl D. Anderson, of California Institute of Technology, presented the accompanying table of elementary particles of matter as known in March, 1951. He pointed out that all the particles discovered since 1932 are unstable and, after living for only a short time, either undergo spontaneous decay or are captured by atomic nuclei.

The elementary character of the particles is uncertain, as is the meaning of the adjective itself in this connection. According to modern physical theories, particles may exist in "virtual" states in which they may have observable effects although they do not actually exist as independent observable particles. Dr. Anderson quotes Dr. Robert Oppenheimer as expressing the best way out: "An elementary particle is one that is so simple that one has no understanding of it whatsoever."

The 15th particle is expected to be the *anti-proton*, of negative charge but with the same mass as the ordinary positive proton. According to a Science Service release dated April 30th, in a cosmic ray disintegration photograph by Dr. Robert B. Leighton, also of Caltech, one track of such a negative proton had been tentatively identified.

ELEMENTARY PARTICLES OF MATTER AND SOME OF THEIR INTERACTIONS

PARTICLE	*Mass in Electron Masses*	*Year Discovered*	*Average Lifetime against Spontaneous Decay*	*Products of Spontaneous Decay*	*When moving slowly can also be removed by "Capture" by*	*Results of Capture*
ELECTRON	1	1896	Stable	—	Positron	Two photons
PROTON	1845	1890–1900	Stable	—	—	—
NEUTRON	1848	1932	About 20 min.	Proton and electron	Atomic nucleus	1. Radioactive isotope 2. Fission products
POSITRON	1	1932	Stable	—	Electron	Two photons
POSITIVE MU MESON	210	1936	2×10^{-6} sec.	Electron and two neutrinos	—	—
NEGATIVE MU MESON	210	1936	2×10^{-6} sec.	Electron and two neutrinos	Atomic nucleus	Nuclear excitation with ejection of neutrino
POSITIVE PI MESON	276	1947	10^{-8} sec.	Mu meson and neutrino	—	—
NEGATIVE PI MESON	276	1947	10^{-8} sec.	Mu meson and neutrino	Atomic nucleus	Nuclear disruption
NEUTRAL PI MESON	264	1950	Less than 10^{-13} sec.	Two photons	Atomic nucleus	Nuclear disruption
POSITIVE V-PARTICLE	Unknown	1947	Less than 10^{-9} sec.	Unknown	—	—
NEGATIVE V-PARTICLE	Unknown	1947	Less than 10^{-9} sec.	Unknown	Unknown	Unknown
NEUTRAL V-PARTICLE	Unknown	1947	10^{-10} sec.	Probably mesons and protons	Unknown	Unknown
PHOTON	0		Stable	None		
NEUTRINO	0		Stable	None		

This table by Carl D. Anderson is reproduced by courtesy of the "American Scientist."

American Astronomers Report

Here are highlights of some papers presented at the 85th meeting of the American Astronomical Society at Washington, D. C., in June. Complete abstracts will appear in the Astronomical Journal.

Double Galaxies

Kepler's third law has been applied by Dr. Thornton Page, of Yerkes and McDonald Observatories, to 20 double galaxies for which he has obtained differential radial velocities from 37 spectra, each spectrum being taken with the slit across both galaxies. The analysis is similar to that by which the masses of double stars are determined from the periods of their revolution around each other.

Dr. Page has had to assume that in each double galaxy the members actually are revolving around their common center of gravity, that the orbits are circular and at random inclinations to our view, and that the node is at a random angle in each orbit. He has used distances derived from the velocity-distance relation for galaxies as a whole, and his results give a lower limit to the average galaxy mass in each pair.

The measured differential velocities range from zero to 360 kilometers per second, with errors of the order of 50 kilometers per second. The results, while tentative, are consistent with the assumption that one third of the 40 galaxies involved have masses of about four billion suns (4×10^9), while two thirds of them are about 130 billion suns (130×10^9). The Milky Way galaxy is believed to total some 200 billion times the sun's mass.

Perseid Meteor Stream

The August or Perseid meteors were ejected from their parent comet, 1862 III, some 40,000 years ago, after the comet's capture by Jupiter, according to Dr. Salah E. Hamid, of Abbassia University, Cairo, Egypt. To determine the age of the meteors, Dr. Hamid had to compute backward to find out how long it has been since the comet's perihelion distance has been within two astronomical units, for at this distance the sun's radiation can cause sufficient ejection of meteoric material from the "ices" of a comet.

Jupiter and Saturn were the only two planets whose actions were considered in computing the secular perturbations of the comet's orbit, which at present is highly eccentric and retrograde, with a period of 120 years. Best fitting the observations are a close approach of the comet and Jupiter 343 revolutions ago, more than 40,000 years, with the consequent altering of the comet's former orbit to make possible the ejection of the meteors.

After that event, only a few dozen revolutions were required to have the ejected material distributed along the entire orbit of the initial meteoric stream, and in those distant days earth dwellers may have seen a Perseid shower of only a day's duration from a very limited radiant area of the sky. Since then, the perturbations of the planets on the meteors themselves have widened the stream so that the shower now lasts more than two weeks each year, and the radiants have become very diffuse. These characteristics of the present meteor stream fit with computed changes during the past 40,000 years.

The Interstellar Medium

It is well known that interstellar gases produce "detached" lines in stellar spectra; particularly noticeable are the lines of ionized calcium. A theory that interstellar matter tends to occur in a random pattern of essentially discrete clouds has been developed to account for the observations. However, Bertram Donn, of Wayne University, has proposed an alternative working hypothesis.

He suggests that the major part of the gaseous medium forms an extensive inhomogeneous cloud partaking of the galactic rotation. This cloud produces an interstellar line in every star and the strongest component of a multiple interstellar line. Some dispersion in velocity exists among the density concentrations in addition to the thermal motion of the atoms. The weaker components with a large velocity dispersion may arise from currents resembling large-scale turbulent elements in the diffuse cloud.

A similar diffuse distribution is suggested for the interstellar dust, but with substantial differences in the density fluctuations for the two forms of matter, dust and gas.

Radio and Telescope

An attempt has been made by Drs. William Blitzstein and F. Bradshaw Wood, and Bernard T. Svihel, of the Flower and Cook Observatories, University of Pennsylvania, to detect high-frequency light oscillations in stellar atmospheres. The output of a photomultiplier cell attached to a telescope was fed directly to the antenna terminals of a radio receiver, testing a frequency range from 500 kilocycles to 30 megacycles per second.

The objects tested included high- and low-velocity dwarfs, shell stars, magnetic and spectrum variables, supposedly normal stars, and one galactic nebula. Tests were also made on small areas of the solar disk at various distances from the center and on sunspots. In all cases the tests did not indicate any detectable modulation of the steady light of the source. For a 2nd-magnitude star, a modulation of one per cent would have been detectable; by suitable modification of the radio receiver, this limit could be considerably decreased.

Atmospheric Refraction

Refraction of the light of celestial bodies within five degrees of the horizon has been measured directly by comparing observed altitudes of the sun, not corrected for refraction, with calculated altitudes based on the position of a ship deduced from observations of stars at moderate altitudes. For this purpose, Dr. G. M. Clemence, director of the U. S. Nautical Almanac Office, analyzed a total of 315 observations by the navigators of 33 ships. He concludes that if there is any error in the theory of refraction at great zenith distances, it does not exceed a few tenths of a minute of arc.

Tides on Mars?

An explanation of the steady increase in the mean motion in longitude of Phobos, Mars' inner satellite, has been sought by Harvard astronomers Dr. Fred L. Whipple and Frank J. Kerr. They have considered as one possibility the effect of a resisting medium of asteroidal and other interplanetary matter, but find that this is insufficient and that it should also affect the motion of Deimos, the outer satellite of Mars. If anything, Deimos' motion tends to decrease, although even this is highly doubtful. Furthermore, the nearest moon to Jupiter also shows (rather uncertainly) a secular acceleration, and were this caused by interplanetary material having a differential velocity of four kilometers per second relative to the planet, Jupiter would be receiving half as much energy from the impact of this matter as it receives for the sun, an unlikely state of affairs. For Mars, the derived space density of the resisting medium, however, is comparable with that in the center of the asteroid belt.

For the Martian satellites, there is more promise in a tidal explanation because tidal effects decrease very rapidly with distance from the planet, in keeping with the small (or zero) acceleration observed for Deimos. Also, the effect should be of opposite sign for the two satellites, because Phobos revolves faster than Mars rotates and

(Continued on page 272)

Amateur Astronomers

Northwest Region Convenes in Canada

THE NORTHWEST REGION of the Astronomical League held its annual convention July 20-21, 1951, at Victoria, B. C., as guest of the Victoria Centre of the Royal Astronomical Society of Canada, which made all local arrangements. More than 50 persons were registered. The Dominion Hotel was convention headquarters.

The opening session was a program of papers on Friday afternoon. A brief business meeting was held after the papers, but an early adjournment was effected in deference to the Yakima group, which was delayed because of failure of the boat to arrive on schedule.

On Friday evening, we were guests of the Dominion Astrophysical Observatory, where the accompanying group photograph was taken. Dr. R. M. Petrie gave a short talk on the history of the observatory and facts concerning the 72-inch telescope. He then set up the telescope for observing, but a hazy sky and a few clouds made this disappointing, and smaller instruments were resorted to for some of the evening's program.

Saturday morning's sessions opened with a series of papers. Among those given at the convention were: "Does Photon Density Control the Velocity of Light?" by H. P. Haggart, of Portland, Ore.; "Duration of Day and Night at Various Latitudes from Equator to Pole," Carl P. Richards, Salem, Ore.; "Dr. John Evans and the Lost Port Orford Meteorite," James H. Karle, Portland; "Chemical Composition of the Stars," Dr. K. O. Wright, Dominion Astrophysical Observatory; "Spectrographic Investigation of Binaries," P. E. Argyle, Dominion Astrophysical Observatory; "Setting Up an Instrument," Robert Peters, director of observations of the Victoria Centre.

At the business meeting the following regional officers were re-elected: C. A. Wood, Portland, chairman, Edward J. Newman, Yakima, national league representative, and Edward V. Lockhart, Jr., Yakima, treasurer. Other officers are Dr. Joseph L. Regimbal, Yakima, vice-chairman; Howard Richards, Portland, corresponding secretary; Margaret Edgar, Portland, executive secretary. The region voted to extend an invitation for the Astronomical League's 1952 general convention to be held in Portland, Ore.

The convention banquet Saturday evening, at the Monterey Cafe, was presented for the guests by the Victoria Centre, with the backing of various Victoria business concerns. Dr. J. A. Pearce, director of the Dominion Astrophysical Observatory, was principal speaker, and his topic was "Current Researches at the Observatory."

Edward J. Newman
Yakima Amateur Astronomers

KEY TO PHOTOGRAPH

First row, left to right: Mrs. W. B. Stockett, Y; Arthur Stockett, Y; Mrs. H. Thomas, Coulee Dam, Wash.; Mrs. C. P. Richards, S; C. P. Richards, S; Mrs. J. R. Noble, V; Sandra Noble, V; C. A. Wood, P; Dr. R. M. Petrie, Dominion Observatory; Mrs. D. C. Smith, S; Mrs. G. J. Hohnstein, P; Mrs. C. A. Wood, P.

Second row, left to right: Clara McNeil, S; R. Shattuck, Y; E. J. Newman, Y; R. S. Evans, V; G. Stoker, V; A. Stocks, V; H. J. Carruthers, P; Mrs. H. P. Haggart, Oregon City, Ore.; H. P. Haggart, Oregon City, Ore.; Margaret Edgar, P; R. Peterson, Bonneville, Ore.; D. Anderson, P.

Third row, left to right: F. Moore, P; R. Harlow, Bonneville, Ore.; T. P. Maher, Heppner, Ore.; J. L. Butler, Gresham, Ore.; A. V. Goddard, P; H. Thomas, Coulee Dam, Wash.; W. B. Stockett, Y; J. H. Karle, P; O. W. Smith, V; G. J. Hohnstein, P; H. J. Richards, P; R. Sloop, Moses Lake, Wash.

P, Portland, Ore.; S, Salem, Ore.; V, Victoria, B. C.; Y, Yakima, Wash.

THIS MONTH'S MEETINGS

Cambridge, Mass.: The Amateur Telescope Makers of Boston will meet on Saturday, September 8th, at the home of Frank Schmelzer in Stowe, at 4:30 p.m. for a barbecue and the concluding summer outdoor program. Members should bring telescopes.

Chapel Hill, N. C.: The opening session of the general convention of the Astronomical League will take place at 10:20 a.m., September 1st, at the Morehead Planetarium of the University of North Carolina. For additional events of the convention program see page 243 of the August issue of **Sky and Telescope.**

Columbus, Ohio: William Protheroe will speak at the meeting of the Columbus Astronomical Society on September 14th, 8 o'clock at McMillin Observatory, on "The Formation of Stars."

Dallas, Tex.: The September 24th meeting of the Texas Astronomical Society will be held in the Lone Star Gas Co. auditorium at 8 p.m. Reports of the Astronomical League general convention, and an astronomical film, will be highlights.

Madison, Wis.: An open house at Washburn Observatory, at which E. Baillie will speak on "Astronomy as a Hobby," will make up the September 12th meeting of the Madison Astronomical Society, 8:00 p.m.

Pittsburgh, Pa.: Glenn A. Winterhalter will conduct a quiz program for the Amateur Astronomers Association of Pittsburgh on Friday, September 14th, at 8:30 p.m., lecture hall, Buhl Planetarium.

Teaneck, N. J.: At the September 12th meeting of the Bergen County Astronomical Society, Maxim White will speak on "Nuclear Energy and the Heat of Stars," at 8:30 p.m., at the society observatory, 107 Cranford Place.

Washington, D. C.: The National Capital Astronomers will meet in the Department of Commerce auditorium on Saturday, September 8th, at 8:00 p.m. Ernest G. Reuning, of the Army Map Service, will lecture on "Possibilities of Travel in Outer Space."

Members and guests at the Northwest regional convention of the Astronomical League, assembled before the 72-inch reflector of the Dominion Astrophysical Observatory. Photo by Mr. Draper of the observatory staff.

HYDROGEN SHOWERS-I

By Otto Struve, *Berkeley Astronomical Department*
University of California

YERKES OBSERVATORY, together with a number of other American observatories, is located near the southern edge of the great belt of auroral displays which surrounds the region of the north magnetic pole of the earth. Because the magnetic pole is in Canada, we, in northern America, are far more favorably placed for observing the aurora than are most European observatories. Only the Scandinavian countries and northern Russia, with latitudes of 60° or more, are within the auroral belt. There is a similar belt in the Southern Hemisphere, centered around the south magnetic pole, about 20 degrees wide.

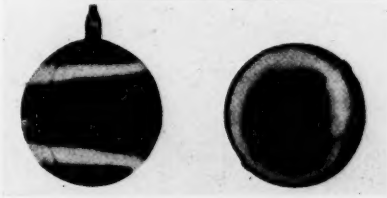
Near the equator of the earth the polar aurora is never visible. Exceptional displays can be seen, occasionally, some 40 degrees from the north magnetic pole, whose location is roughly at latitude 70° north, which just about places the southern edge of the belt at our Mexican border. With increasing magnetic latitude the frequency of auroras increases, until a maximum is reached at a distance of about 20 degrees from the magnetic pole. This is roughly across central Hudson Bay to Point Barrow, Alaska. At magnetic latitude 70°, auroras can be seen on about two nights out of three. Still closer to the magnetic pole the frequency of displays again diminishes.

The northern lights appear in a great variety of forms. Some are relatively quiescent, and are distinguished as general "auroral fog," without definite limits, as horizontal luminous arcs near the northern horizon, or as vertical streamers and "draperies." There are also rapidly changing auroras, with streamers moving up and down or sideways. The most amazing form is the pulsating aurora, with large and small patches of light that pulsate at intervals of eight to 10 seconds. The patches themselves may remain fairly constant in outline for several minutes, but occasionally they, too, vary in an extraordinary manner. They remind one of the effect of sprays of water whipped up by a strong gale and thrown at the face of a passenger on the deck of an ocean liner.

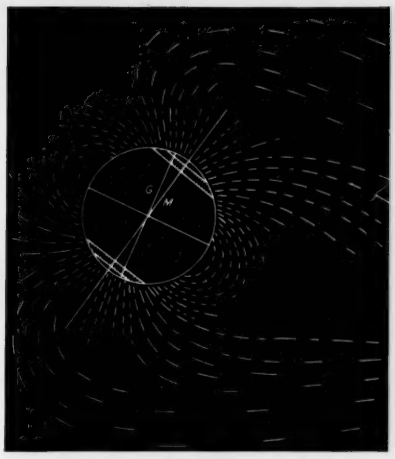
The isolated rays and streamers are probably the most typical forms of auroral display. In 1914, L. Vegard and his associates in Norway showed that these streamers follow approximately the lines of force of the permanent magnetic field of the earth. Since at our latitudes most of the displays occur north of us, we see most often a series of vertical streamers above the northern horizon. But occasionally a display may come in from overhead, along a line of force which crosses into the atmosphere at our particular magnetic zenith. When that happens we see a magnificent auroral corona, with brilliant rays emerging from the magnetic zenith as a radiant point, and diverging from it in all directions toward the horizon. It was a display of this kind that occurred on August 18-20, 1950, and was photographed by Stewart Sharpless with the Henyey-Greenstein wide-angle camera at Yerkes Observatory, described in the July issue (page 215). Four photographs of this fine sequence of pictures are reproduced on the next two pages.

As long ago as 1896, K. Birkeland laid the necessary foundations for the development of the ideas relating the magnetic field of the earth and the aurora. He placed a small magnetized metallic sphere — the terrella — in a vacuum chamber and bombarded it with strong cathode rays, or, as we now say, with negatively charged electrons. The surface of the terrella was covered with fluorescent material, so that the impact of the electrons could be observed by the luminous glow they produced. With a proper choice of the velocity of the electrons and the magnetic field of the terrella, the glowing areas were limited to two belts, one near the northern, the other near the southern magnetic poles of the sphere. Birkeland also noticed the close correlation between the frequencies of northern lights and of sunspots, in their 11-year cycle, and he advanced the hypothesis that streams of charged particles originating in the sun give rise to the auroras. But the nature of the particles remained unknown.

Several years later Svante Arrhenius suggested that these particles could be



The terrella in an experiment by K. G. Malmfors in 1946, similar to that by Birkeland. On the left the terrella is viewed from the "night" side, the north pole being upwards and the evening side to the left. On the right the terrella is viewed from above the north pole, with the sun toward the top.



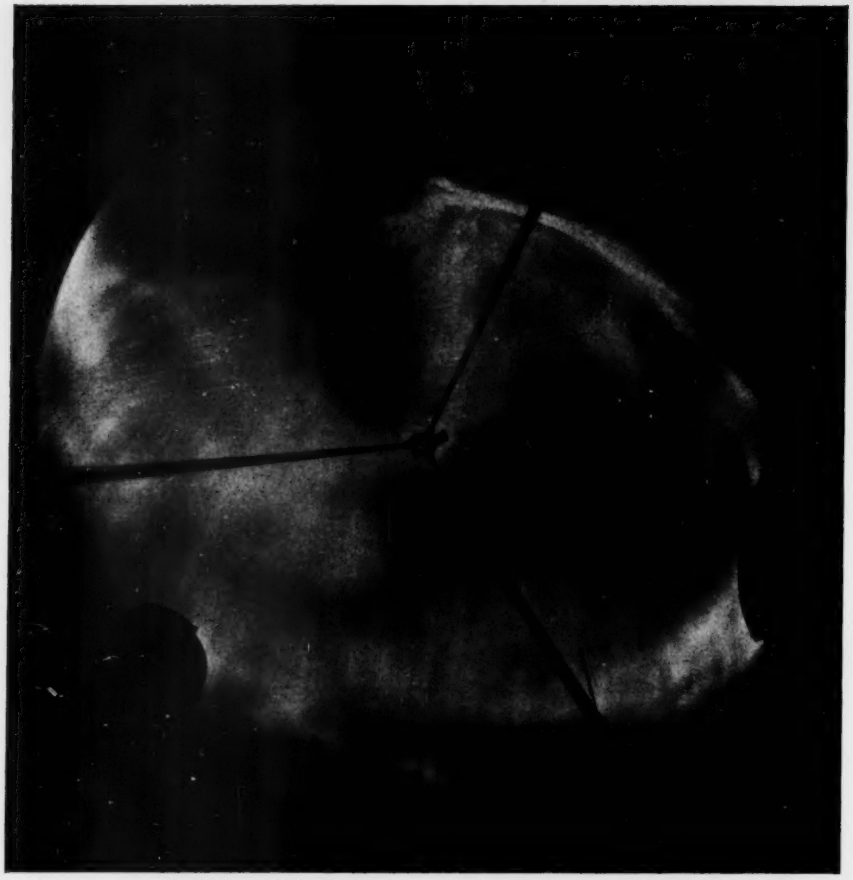
A much simplified diagram of the manner in which streams of charged particles from the sun may enter along the lines of force of the earth's magnetic field, producing the zones of greatest auroral intensity in the Northern and Southern Hemispheres. G is the geographical axis of the earth, M is the geomagnetic axis.

in the form of dust, while Vegard was concerned with determining the sign of the charge: positive, as in ions, or negative, as in electrons.

The experiments of Birkeland were continued by other workers, particularly by a group of Scandinavian geophysicists, and were fully explained by the theory of Carl Stoermer. He showed that a charged particle from the sun will be deflected by the earth's magnetic field in such a way as to move toward one of the poles, and at the same time spiral around the earth and penetrate into the atmosphere on the night side. A negative particle, such as an electron, will be deflected greatly toward one side, while a positive particle, such as a proton with its much greater mass, will be deflected by a smaller amount in the opposite direction.

As a general rule, large auroral displays are related to the passage of a disturbed area across the central meridian of the sun. Such an area, characterized by a magnificent prominence eruption at the limb of the sun on August 7, 1950, has just been described by Helen W. Dodson and Robert W. Donselman, of the McMath-Hulbert Observatory of the University of Michigan (*Astrophysical Journal*, May, 1951). This region was again active on August 15th and 16th, when it was seen as an area of dark filaments and bright plages on the disk of the sun. It crossed the central meridian on August 16th, and two days later gave rise to the August 18-20 aurora.

But there are many auroras, as well as magnetic storms, which are not directly related to sunspots, prominences, flares, and the like. In fact, sometimes a brilliant aurora, such as the one of



July 1-2 this year (reported by several amateurs on page 279 of this issue) has nothing unusual to be associated with on the face of the sun. Still, if we go back in time, we often find that one, two, or more solar revolutions earlier a magnetically active area or *M* region was the seat of a large eruption, although it is now indistinguishable from the rest of the sun's surface.

It has been found repeatedly that large eruptions on the sun, in the form of violent prominences, are often associated with distinct streamers in the corona of the sun. Most of the material erupted in a solar prominence undoubtedly returns to the sun's surface — McMath-Hulbert and High Altitude Observatory motion pictures show the falling filaments after such eruptions. But a part of the material escapes permanently from the gravitational field of the sun and is accelerated outward by radiation pressure. As Edison Pettit and others have shown, the accelerated motions are sometimes very large: hundreds of kilometers per second are not exceptional speeds.

Presumably, these solar particles or corpuscles are ordinary atoms, neutral or ionized as the case may be. As they speed away from the sun, they are subjected to the intense continuous spectrum of solar radiation and are still more accelerated outward. This occurs because their outward motion makes them "see" the light of the photosphere, below, displaced toward the red by the Doppler effect. When they were stationary, they could "see" or absorb only the sunlight of reduced intensity that had been partially absorbed by similar atoms below them producing a solar absorption line. But their high outward motion renders them insensitive to the light within the line; they thus experience the full glare of the continuous spectrum. This mechanism, proposed in 1926 by the late E. A. Milne, of Oxford, results in an ultimate velocity of about 1,630 kilometers per second, corresponding to an interval of 27 hours for the atoms to travel between the sun and the earth, and thus accounts for the lag of one or two days between passage of a prominence area over the central meridian and the beginning of an aurora or a strong magnetic storm on the earth.

In 1929, S. Chapman proposed a simple method to test Milne's theory. During a strong and prolonged magnetic storm, the line of sight between the earth and the sun should be saturated with rapidly approaching atoms. Perhaps these atoms could be discovered

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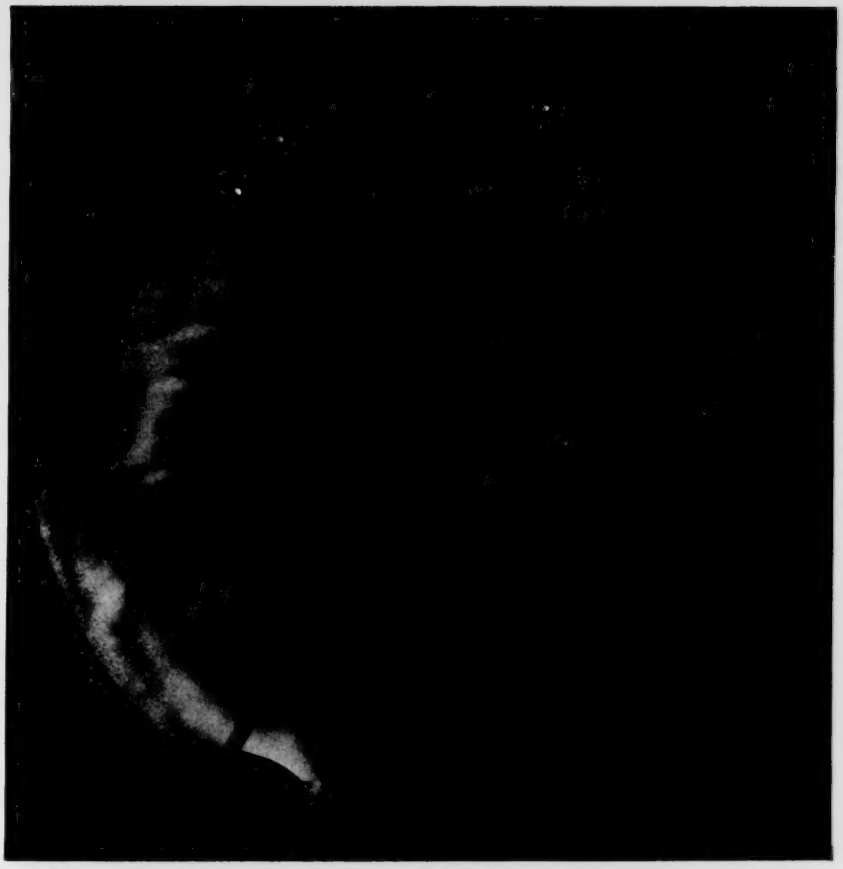
by their absorption of solar radiation.

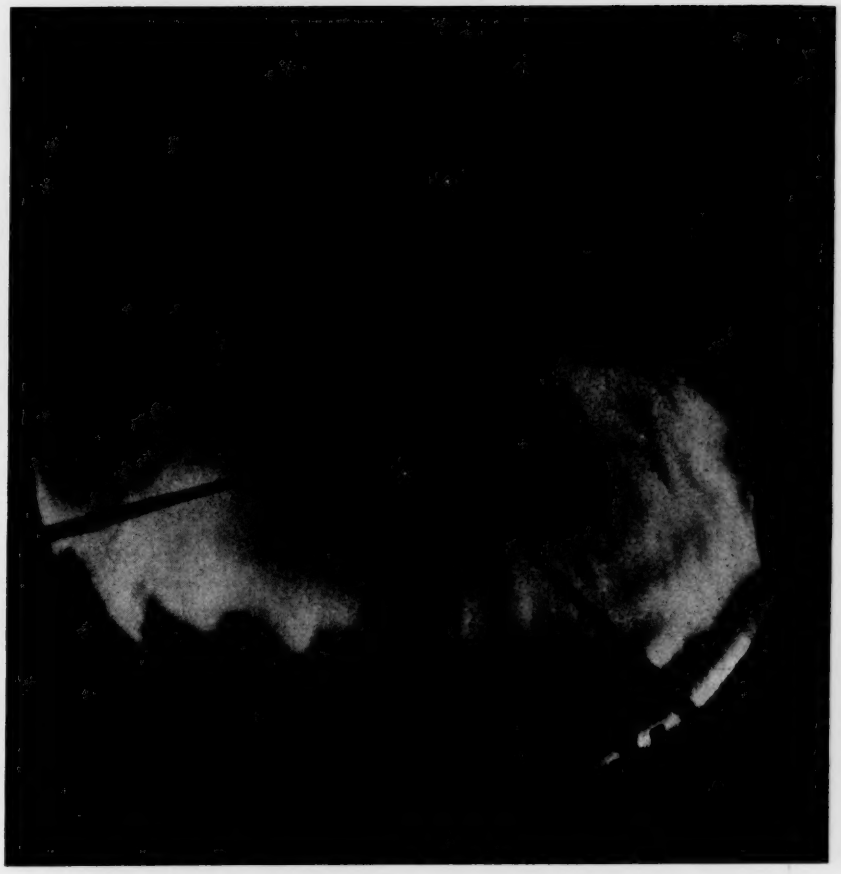
This test was carried out at Mount Wilson in 1941-42 by R. S. Richardson, who found in the solar spectrum during a magnetic storm a pair of shallow violet-displaced absorption lines of H and K of ionized calcium. By the Doppler effect, the motion of the calcium atoms was found to be between 600 and 1,000 kilometers a second toward the earth. Richardson's result was confirmed, in 1946, by H. A. Brück and F. Ruttlant, at Cambridge, England, who found the velocity of the calcium atoms to be 750 kilometers per second.

In both of these observations, the particles were seen between the earth and the sun. In all likelihood they had not gone far from the sun, since their velocity was considerably smaller than the limiting velocity computed by Milne, and their paths had not been greatly deflected from a straight line by either the sun's or the earth's magnetic field.

These approaching particles, if they hit the earth face on, would penetrate into our atmosphere only during the day. They could not produce the auroral displays observed at night, which, according to Vegard, occur most frequently about one hour before "magnetic midnight." The latter differs slightly from ordinary solar time because the magnetic axis of the earth is inclined to the axis of rotation, but for most practical purposes it is sufficient to assume that the two kinds of time are the same.

The question of the nature of the charged particles remained a puzzle. A. Schuster, and later F. A. Lindemann, pointed out that streams of uniformly charged particles could not persist for the many hours required to travel between the sun and the earth. Since atoms of the same charge would repel one another, the stream would disperse in a very few seconds! But perhaps the stream, as a whole, is electrically neutral even though the individual atoms may be ionized. This, in effect, is the basis of the more recent theories by Chapman and V. Ferraro, on one side, and by H. Alfvén, on the other. We shall discuss this further next month, and also the observations at Yerkes Observatory by A. B. Meinel of the motions of incoming hydrogen atoms as revealed by the spectrum of the aurora of August 18-20, 1950.





The aurora on August 19-20, 1950, photographed by Stewart Sharpless with the Henyey-Greenstein wide-angle camera. All four pictures are on Eastman 103a-F emulsion, 10 seconds exposure. Vega, Altair, and Deneb may be identified in the upper right of each picture, arranged as in a mirror image of the sky; north is at the bottom, south at the top, east at the left. Yerkes Observatory photographs.

The penumbral lunar eclipse of March 23, 1951, photographed at the Griffith Observatory, Los Angeles, by Paul E. Roques. The conspicuous darkening of the northern (lower) part of the full moon could not be observed visually.

The Limit of Visibility of Eclipses

By Edward M. Brooks

Institute of Technology, St. Louis University

THE LIMIT of visibility of an eclipse depends not only on the magnitude of the eclipse, but also on the vision, training, and psychology of the observer, and on the clearness of the earth's atmosphere. The purpose of a study by the writer was to find the lowest possible eclipse magnitudes visible to human eyes without the aid of magnification, corresponding to the most favorable factors listed above. This was done by computing eclipse magnitudes at the beginning and end of the period that an eclipse was visible, and by visually estimating the percentage of obscuration at mid-eclipse.

The events chosen for study were small eclipses near the limit of visibility, so that errors in estimating times of beginning and ending gave small errors in the computed eclipse magnitudes. The solar eclipse was that of November 12, 1947, of magnitude 0.05 in St. Louis. Also chosen were the penumbral lunar eclipses of December 28, 1936; May 25, 1937; November 28, 1947; October 17, 1948; and March 23, 1951, observed by the author. Independent observations of the 1947 and 1948 lunar eclipses were also made by Edwin E. Friton (regional director of the American Meteor Society).

The limiting magnitude of a solar eclipse is greater than zero because the new moon is not visible by itself. Enough of the moon's limb must encroach on the sun so that its concave curvature can be distinguished from the convex curvature of the sun's limb. The November 12, 1947, solar eclipse was not visible for the first four minutes and the last two minutes. The average of three minutes invisibility at each end of the eclipse gives a limiting magnitude of 0.01. The length of the moon's limb visible for this magnitude is six minutes of arc, which is consistent with the eye's four- or five-minute limit[1] for recognizing shapes. With telescopic magnification, the limiting magnitude is much nearer to 0.00 because the visible moon's limb appears longer. Obviously, first and last contacts can be measured accurately only with magnification.

The limiting magnitude of a lunar eclipse is less than zero, because the edge of the earth's umbra is at some distance from the moon's limb when the limb's reduced brightness due to the earth's penumbra is barely noticeable. At the limit of visibility, the reduction in brightness of the moon's eclipsed limb should be a nearly constant percentage of its uneclipsed brightness, according to the Weber-Fechner law[2]. The actual reduction in brightness necessary is more than the one per cent given by Ball[3] because of the unconscious adaptation of the eye to decreasing brightness as the eclipse increases. Mental comparison should be made with previous conditions rather than with the opposite uneclipsed limb of the moon, inasmuch as the normal brightnesses of the north and south limbs are different. Corresponding to the constant percentage of uneclipsed brightness, there is a constant fraction of the sun's diameter (perpendicular to the edge of the umbra) which would be visible from the moon's eclipsed limb. This constant fraction is approximately as much above zero as the eclipse magnitude is below zero.

Alexander Pogo stated in 1937[4] that experienced observers and professional astronomers can see eclipses to lower eclipse magnitudes than inexperienced observers. He also defined[5] the interval of time between the beginning of suspected darkening and unmistakable darkening as the "duration of hesitation." Pogo's definition of the limiting eclipse magnitude is that corresponding to the average time of unmistakable darkening as witnessed by an average inexperienced observer. The definition used in the present study is the magnitude corresponding to suspected darkening seen by an *experienced* observer.

Pogo found, according to his definition, an average limiting magnitude of −0.30 (meaning that 0.30 lunar diameter, or about nine minutes of arc, separates the moon's limb from the earth's umbra). The author found on the basis of five penumbral lunar eclipses observed without magnification, but some seen with the aid of filters, that the lowest magnitudes visible for each eclipse ranged from −0.51 to −0.63. For four eclipses of the north limb of the moon the average was −0.58; and the other eclipse, of the south limb (November 28, 1947), was visible to an eclipse magnitude of −0.60.

It is suggested that amateur astronomers make observations of the penumbral eclipse of September 15, 1951, which will reach a maximum magnitude of −0.17 at 12:26 Universal time (12 minutes before full moon) on its south limb[4]. If it is visible for a magnitude greater than −0.60,

its visible beginning will be at 10:55 UT for the Middle West and the Far West, where the moon will set while still in the penumbra of the earth's shadow. Please send any limiting magnitude observations of this eclipse to the author at the Institute of Technology, St. Louis University, 3621 Olive St., St. Louis 8, Mo.

This is the fourth appulse or penumbral lunar eclipse this year, the others having occurred on February 21st, March 23rd, and August 17th. It is suggested that because of the increasing interest in such phenomena the former practice of tabulating the circumstances of penumbral lunar eclipses in the *American Ephemeris and Nautical Almanac* be resumed.

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2. H. R. Blackwell, "Contrast Thresholds of the Human Eye," *Journal* of the Optical Society of America, *36*, 624, 1946.
3. James M. Ball, *Modern Ophthalmology*, 62.
4. Alexander Pogo, "The Limit of Visibility of Penumbral Lunar Eclipses," *Popular Astronomy*, *45*, 349, 1937.
5. Alexander Pogo, "On the Visibility of Lunar Appulses," *Popular Astronomy*, *45*, 126, 1937.

LETTERS

(Continued from page 262)

agine that in Wright's **Original Theory of the Universe** (1750), in the translations of Kant's **Theory of the Heavens** (published in German in 1755), in the translation from the French of Lambert's **Cosmological Letters** (1800), or in William Herschel's writings (around 1800), we might find the present English term, since these authors all were believers in "island universes." Duncan (**Astronomy,** 2nd revised edition, page 393) mentions "island universes in the sense in which the term was used by Herschel." Jeans (**The Universe Around Us,** 1929, page 27) states that Herschel "spoke of these objects as island universes."

Nevertheless, to corroborate Dr. Hubble, I have failed to find the expression in any of the above-mentioned works. Herschel did speak of them as "universes" to Fanny Burney, and he did write of them as "Milky Ways," "clusters," "stellar systems," "star clouds," and "star groups."

Yet it is to be considered that Herschel did a great amount of writing; perhaps some reader of **Sky and Telescope** has come across the term "island universes" somewhere among his papers or letters. Several writers in the 18th century came close to giving the external galaxies this term. Young, in his **Night Thoughts,** for instance, speaking of our universe likens it to an isle in the ocean of space, a space that contains continents as well.

Searching further, the earliest use of the exact English expression "island universes" that I have been able to locate is in O. M. Mitchel's **Planetary and Stellar Worlds** (1848, page 283). Do any readers know of any mention of it prior to this date?

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TERMINOLOGY TALKS

J. Hugh Pruett

Modern Star Designations

Star names serve well enough for the brightest stars, but with those visible to the naked eye running into thousands, and the telescopic stars into hundreds of millions, we certainly need more simplified methods for designating stars than were devised by the ancients.

In 1603 — a few years before the invention of the telescope — the young German astronomer Johann Bayer published his star atlas, the *Uranometria,* and on the maps introduced a new method for designating the brighter members of the various constellations. His method is still in general use today, and employs a Greek letter followed by the genitive case of the constellation name. The letters α, β, γ, δ, ε, . . . (alpha, beta, gamma, delta, epsilon, . . .) are used generally in the order of brightness of the stars. Regulus, the brightest star in Leo, thus becomes α Leonis, or Alpha of Leo; Denebola, the next in brightness, is β Leonis.

As pointed out in Astronomical Anecdotes by Dr. Roy K. Marshall (*Sky and Telescope*, March, 1943), Bayer's designations only roughly correspond to the sequence of brightnesses in a particular constellation. And in cases where the stars do not differ greatly in brightness, they are lettered in the order of their positions in the group. In the familiar Big Dipper, α is at the lip of the bowl and the other Greek letters follow in order, tracing the entire figure out to the end of the handle. In cases where the Bayer method exhausts the Greek alphabet, the Roman letters, such as we use in our printing, are employed.

Late in the century that Bayer's work appeared, John Flamsteed, the first Astronomer Royal of England, devised another method for designating the stars in a constellation. He gave them numbers according to increasing right ascension. Since right ascension increases from west to east, the first naked-eye star he could detect in the western part of a constellation was numbered 1. In the case of Cygnus, this would be 1 Cygni. The next one eastward became 2 Cygni. Students of astronomy are quite familiar with 61 Cygni, for it is famous as the star to which the distance was first measured, by Bessel in 1838. It is of apparent magnitude 5.6, but telescopically it is a beautiful orange double, the components being of almost equal magnitude.

Many stars in a constellation not labeled by Bayer were included in Flamsteed's numbering system. But as the necessity grew for working with stars fainter than Flamsteed's, other methods of designating them had to be developed. One of these is simply to use the numbers given them by various cataloguers. Thus Σ3058 means the 3,058th star listed in the catalogue of Wilhelm Struve; β1095 refers to Burnham's catalogue; Lalande 21185 to Lalande's catalogue. The famous *Bonner Durchmusterung* catalogue of 324,000 stars compiled by Argelander is usually designated as the BD, and is in zones by declination; thus, a star may be designated as BD +66°24. The stars in the *Henry Draper Catalogue* of spectral types are indicated with the initials HD. There are numerous other catalogues and compilations, and a star may have many different designations.

Variable Star Designations

We often note in astronomical articles such names as R Coronae Borealis, SS Cygni, and V335 Aquilae. These apply to variable stars, and the exact letters or numbers to the order in which they were discovered in each constellation. At first there were so few known variables that a single letter sufficed, and those from R to Z were used. When more than nine variables were found in a constellation, the 10th was called RR, the 11th RS, and so on until the 18th was RZ. Then SS to SZ were used, and finally ZZ. This takes care of 54 variables, but if there are more in a constellation we use AA, AB, . . . AZ; BB, BC, . . . BZ (J is omitted throughout), until QZ is reached for the 334th variable (count them if in doubt). After that a really easy method is used. For the 335th variable we find simply V335, for the 336th, V336, and so forth.

Dr. Paul W. Merrill, of Mount Wilson and Palomar Observatories, tells us in his *Nature of Variable Stars,* published in 1938, that then the variables exceeded 334 in each of six constellations.

CHEMISTRY ON A COSMIC SCALE

Five special demonstrations will be held at the Hayden Planetarium in New York City on the occasion of the diamond jubilee meeting of the American Chemical Society and the 12th International Congress of Pure and Applied Chemistry. Upon the invitation of the American Cyanamid Company, members and guests will see, in the planetarium chamber, a demonstration of "Chemistry on a Cosmic Scale," by S. I. Gale, assisted by Robert R. Coles, planetarium chairman, and Dr. E. I. Stearns. The special showings are scheduled for 9 p.m., September 4th; 4 and 9 p.m., September 6th; 11 a.m., September 7th; and 9 p.m., September 11th. Tickets may be obtained from the American Chemical Society headquarters at the Hotel Statler, New York City, or by writing to Dept. 209, American Cyanamid Company, Calco Chemical Division, Bound Brook, N. J.

NEWS NOTES

By Dorrit Hoffleit

PLANETS AND WHITE DWARFS

In 1935, Henry Norris Russell pointed out that planets and white dwarfs form a single family, assuming that they are chemically homogeneous and that the chemical composition is the same for all. It then follows that the only independent variable between them is mass, the other properties such as mean density and radius being simply related to the mass. However, among the planets the radius increases with mass, whereas the opposite is true for the white dwarfs.

Both these types of objects are considered cold bodies, in that the density at any point in the interior depends only on the pressure and not on the temperature to any appreciable degree. Thus Russell had noted that there must be a maximum possible radius for a cold body, and observations indicated that this maximum must correspond to a mass or radius not much larger than Jupiter's.

Russell did not justify this planet-white dwarf relationship on the basis of atomic theory. This has now been done by W. H. Ramsey, of the Physical Laboratories at Manchester University. In the *Monthly Notices* of the Royal Astronomical Society, he reports that the maximum radius depends on the chemical composition, and that it is 85,000 kilometers for hydrogen.

MERCURY'S ATMOSPHERE

While the small mass of Mercury does not enable the planet to hold an extensive atmosphere, it has been believed that it might, for cosmic periods of time, be able to retain a thin atmosphere of the heavier gases. Except for inferences deduced from transitory surface markings observed visually, there has heretofore been no direct evidence for the existence of a thin atmosphere on Mercury. But recently at the Pic du Midi Observatory in France, A. Dollfus was able to obtain such proof from his studies of the degree of polarization of the light from the planet, using a 23½-inch telescope at 900 power. He found that near the quarter phases the dark regions of the surface showed greater polarization than the bright regions. This corresponds to what had previously been found for the moon and implies that the surface structures of the two bodies may be similar. Dollfus also found that the polarization is different in red and in green light, which indicates the presence of an atmosphere. And if the atmosphere had a composition like that of the earth's it would be only 3/1,000 as thick. This research is reported in the *Comptes Rendus* of the French Academy of Sciences and is briefly reviewed in the *Journal* of the British Astronomical Association.

TIDES IN THE ATMOSPHERE

Technology Review (June, 1951) announces results of an investigation on dynamic tides in the earth's atmosphere by Drs. L. Jacchia and Z. Kopal, Massachusetts Institute of Technology, sponsored by the National Advisory Committee on Aeronautics.

On the surface of the earth the tide-producing force of the moon is about 2.2 times greater than the corresponding effect from the sun, and the observed amplitudes of the lunar and solar components of ocean tides are in about that ratio. But the tides of the upper atmosphere are quite different, the solar component being about 45 times the lunar. This is explained by resonance.

"One of the free periods of oscillation of the atmosphere is so close to 12 hours that the pressure oscillations with the solar period are greatly enhanced." Knowledge of these atmospheric pressure tides can be used for determining a standard temperature profile of the atmosphere which is consistent with evidence from other sources.

MONZE METEORITES

Shortly after four o'clock the morning of October 5, 1950, inhabitants of the Rhodesias were awakened by the intense glare of a meteor so bright that it rendered the moon inconspicuous, followed by an explosion and rumbling noises, the detonation being heard over an area of some 20,000 square miles. This was succeeded in a more localized area by the swishing sounds of falling stones. When daylight came, three fragments of the stony meteorite were picked up, and subsequent searches netted a total of 15 pounds of small pieces (averaging about two inches across).

The dramatic accounts of the event are summarized in the *Monthly Notes* of the Astronomical Society of South Africa by H. H. J. Lambert, government geophysicist for Northern Rhodesia. He estimates that the detonation occurred about 30 miles north-northwest of the town of Monze, and delimits the search area for fragments to a region about 18 miles square between east longitude 27° 15′ and 27° 30′, south latitude 15° 45′ and 16° 00′. One large stone that apparently broke a log in two and buried itself some four feet in the ground has been reported since Mr. Lambert's original survey. Owing to the temporary absence of the discoverer, it had not been recovered at the time the article was written.

TECHNETIUM ON THE SUN

Technetium, element 43, had to await the advent of the cyclotron for its first discovery here on earth, by University of California physicists who transmuted molybdenum into technetium by neutron bombardment. Now that enough technetium has been produced from Oak Ridge atomic experiments for its spectrum to be observed, Dr. Charlotte E. Moore, of the National Bureau of Standards, has made a search for this element in the sun's spectrum.

Three lines for the neutral atom should be present in the sun, but one is masked by a line of chromium and the other two are absent. For the singly ionized atom, there should be three lines in the observable region, two of which are masked by other elements. The third, however, appears to coincide with a hitherto unidentified line at 3195 angstroms, of Rowland intensity −1.

There is one puzzle in connection with this identification. The half life of the longest-lived isotope of technetium thus far known is several hundred thousand years, which is short for the sun. If an isotope of this element could be found having a half life of around 400 million years, Dr. Moore would feel more secure in her identification of technetium in the solar spectrum.

IN THE CURRENT JOURNALS

NEON IN THE STARS, by Paul W. Merrill, **Leaflet** No. 266, Astronomical Society of the Pacific, June, 1951. "The very name **neon** means new. . . . Widespread throughout the universe, it is older than the hills and the stars."

COMETS, by Fred L. Whipple, **Scientific American,** July, 1951. Astronomers have recently constructed some plausible theories about the composition and origin of these periodic visitors to the center of the solar system.

AN ASTRONOMICAL VISIT TO SOUTH AFRICA, by John B. Irwin, **Publications,** Astronomical Society of the Pacific, June, 1951. "American observatories in Africa have been brilliantly successful in accomplishing those things which they set out to do" in spite of the facts that they have been "run on a shoe string" and have been "seriously undermanned."

AMERICAN ASTRONOMERS REPORT

(Continued from page 265)

Deimos does not. The application of Jeffreys' tidal theory shows that tides in the mantle of Mars would be many times too small to account for the effect if the viscosity there is similar to that in the earth's mantle. If the core of Mars is liquid, however, tidal friction between the core and the mantle might be induced by Phobos, of sufficient magnitude to account for the observed secular changes in the satellite's motion.

BOOKS AND THE SKY

THE ORIGIN OF THE EARTH

W. M. Smart. Cambridge University Press, London and New York, 1951. 239 pages. $2.75.

PROFESSOR SMART'S book is a simple and straightforward description of the solar system, and of theories of its origin. The treatment is of classical directness and restraint — in pleasant contrast to some extravagantly popularized speculative treatments of the same subject in recent years.

The book opens with an excellent description of the earth, moon, and planets, their constitution and their motions. Especially well treated is the problem of the retention of atmospheres, which springs naturally out of the discussion of masses and dimensions. The first of the book's three sections, entitled "Whence?" suffers, perhaps, from the relatively slight emphasis placed upon the sun. A description of the solar system that does not give first place to its central body suggests "Hamlet without the Prince."

The second section, entitled "When?" gives an account of the historical development of knowledge of the solar system's age, beginning with the theory of contraction and leading up to the carbon cycle. The reader might infer that the theory is as successful for all stars as it seems to be for the sun, and one misses a qualifying statement concerning the very real problems of the energy sources and ages of giant stars. Two concluding sections of the chapter deal with the recession of the galaxies (which is a more elastic witness to the astronomical timescale than the author implies), and to the history of the earth-moon system, which, though relevant, would perhaps have fallen more naturally at the beginning of the chapter than at the end of it.

The accounts of various hypotheses of the development of the solar system form the very interesting third section: "How?" Perhaps the fission and Cepheid theories, and the supernova theory, deserve less serious consideration than they receive. And it is a pity that the most acceptable modern view, best integrated in recent years by Kuiper, is not mentioned at all. Neither is reference made to the work of Spitzer, who has shown that gas torn from a pre-existing sun (as in some forms of tidal or encounter theories) could not condense into planets, but must dissipate explosively into space.

The book is so full of sound classical discussion of the basic facts of the solar system that criticism of minor points may seem misplaced. However, we may mention that the dissipation of the Leonid swarm of meteors by repeated encounters with the earth (page 33) is very unlikely, considering the relative dimensions of the earth and the diameter of the swarm. Comets that have entered the solar system in hyperbolic orbits must be regarded as unsubstantiated; and the idea that the comets of the solar system constitute a permanent cloud, suggested many years ago by Opik and recently developed by Oort, is more generally held than the idea that they are the result of chance captures from an interstellar nebulous and dusty region.

In the course of the discussion of the retention of planetary atmospheres, mention is repeatedly made of the loss of original planetary heat. This question is a much-debated one among geophysicists and geologists. The author apparently accepts with favor the rather speculative suggestion that Pluto and Triton were once direct satellites of Neptune, and that their present status is a result of a close encounter between the two.

The Origin of the Earth can be recommended as a dignified and classical account of the nature, age, and development of the solar system. The main criticism is that it is not up to date in several important areas; most of the other points that might be raised are concerned with matters of opinion, in a subject where a consensus has not yet been reached. One would have enjoyed more photographs, but, of course, their inclusion would have increased the cost of the book appreciably.

FRED L. WHIPPLE
Harvard College Observatory

THE NATURE OF THE UNIVERSE

Fred Hoyle. Harper and Brothers, New York, 1950. 142 pages. $2.50.

"ACCORDING TO HOYLE" as applied to this book means something vastly different from the everyday use of the expression. For it is very difficult to avoid the impression that Fred Hoyle's capitalized "New Cosmology" is anything more than a latter-day "A Brief Biography and the Unparalleled Discoveries etc.," with emphasis on the unparalleled discoveries.

The basic criticism of Hoyle's book is that he fails to make perfectly clear to his readers **at all times** what is fact and what is speculation. Moreover, his own speculations receive the spotlight (which is understandable) and are mostly presented in such a way as to indicate that they are widely accepted (which is unforgivable).

Hoyle begins by outlining the general plan for the book, and with a warning that he is going to have to discuss various issues that are still controversial, but these are seldom identified as controversial when he gets to them. Following some remarks about observational and theoretical astronomy, he proceeds to a straightforward discussion of the earth, moon, and planets. The chapter on the sun and the stars is still on pretty safe ground, although one wonders a bit about the claims of "accuracy and elegance" for calculations of the size and brightness of the sun on the basis of the carbon cycle. Perhaps the observed size of the sun isn't such a bad datum to use after all.

The chapters on the origin of the stars and the future and fate of the stars are the first step onto truly insecure ground. And Hoyle's insecurity here is increased unnecessarily because he has apparently not paid any real attention to the data and conclusions of a great many competent and well-informed people, such as Struve

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Harvard Observatory
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and Chandrasekhar, for example. Hoyle's next book might be a better one if he were to drink tea at some other places in addition to Cambridge.

The discussion of the time-scale is good as far as it goes. But there are some who will feel that the evidence from stellar motions and star clusters for the age of the galaxy should not have been omitted, especially when Hoyle bases so much of the argument on his opinions about the still unsettled question of the red giants. The amazing agreement of the time-scales from the earth, meteorites, disintegration of star clusters, and the expansion of the universe, certainly suggests very strongly the possibility that the entire observable universe started its present course of development between two and three billion years ago. Hoyle's five billion year time-scale may be right, but it isn't established yet.

In the chapter on the origin of the earth and planets Hoyle's provincialism reaches its apex. No consideration is given to the important recent work of Whipple, Spitzer, Kuiper, and many others. Instead, it is dogmatically asserted that the planets were formed when a companion to the sun exploded as a supernova. This is not a generally accepted idea, and it certainly is beset with at least as many difficulties as some of the more widely held current ideas. Hoyle's estimate of "about 1,000,000 possible abodes of life within the Milky Way" is based on this highly uncertain theory of the origin of the solar system. The one redeeming feature in this chapter is the brilliant final paragraph:

"Let us end by putting all this in another way. I have often seen it stated that our situation on the Earth is providential. The argument goes like this. It is providential that the Earth is of the right size and is at the right distance from the Sun. It is providential that the Sun radiates the right kind of light and heat. It is providential that the right chemical substances occur on the Earth. A long list of this sort of statement could be compiled, and to some people it looks as if there is indeed something very strange and odd about our particular home in the Universe. But I think that this outlook rises from a misunderstanding of the situation. Because if everything was not just right we should not be here. We should be somewhere else."

The next chapter starts with a good account of the observational basis for the belief that the universe is expanding. In his attempt at simplification Hoyle makes a mistake when he writes that "the light from the galaxies is reddened" instead of saying that the lines in the spectra of the galaxies are shifted toward the red. But then Hoyle is not the first writer to confuse and misinform his readers on this particular point.

The expanding universe chapter also introduces the idea that matter is being continuously created. This is an interesting and possibly fruitful line of thought, and it has important philosophical implications. As Hoyle states:

"To conclude, I should like to stress that so far as the Universe as a whole is concerned the essential difference made by the idea of continuous creation of matter is this: Without continuous creation the Universe must evolve toward a dead state in which all the matter is condensed into a vast number of dead stars. The details of the way this happens are different in the different theories that have been put forward, but the outcome is always the same. With continuous creation, on the other hand, the Universe has an infinite future in which all its present very large-scale features will be preserved."

The book is concluded with a chapter titled "A Personal View." This is interesting, whether one likes it or not. Read in connection with the earlier chapters it helps to show that Hoyle should be regarded as a philosopher and not a scientist. Skill in manipulating the tools of science is not enough to make a scientist. Attitude is also important, and Hoyle's attitude throughout the book is that of the philosopher. The "New Cosmology" is, therefore, a large dose of philosophy spiced with a little science.

FRANK K. EDMONDSON
Goethe Link Observatory
Indiana University

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PHYSIQUE DE LA PLANETE MARS, *Gerard de Vaucouleurs*, 1951, *Editions Albin Michel*, Paris, France. 420 pages. 825 fr.

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EDITED BY EARLE B. BROWN

How to Build a Quartz Monochromator — VI

By Richard B. Dunn, *Harvard Observatory*

WHEN the individual filter elements are assembled for the final testing with the spectrograph, the axes of the crystals and polaroids need be aligned only within about a degree. This alignment can be done mechanically if the orientations of the crystal and polaroid axes have been marked earlier. If not, find the optical axis of each crystal by one of the methods described last month.

Light reflected from a stack of thin glass plates is plane-polarized when the incident angle is about 55°. View such light through each polaroid element while rotating it, and when the transmitted light shows a minimum intensity, the plane of orientation of the polaroid is perpendicular to the reflecting surface. A check can be made with the spectroscope. After two of the polaroids have been set parallel by adjusting for their greatest transmission, a crystal element may be rotated between them until the transmission and absorption bands are the strongest. The axis of the crystal is then at 45° to the axis of the polaroids.

After the entire filter has been assembled in this way, the unit should be heated until the transmission band superimposes on the hydrogen-alpha absorption line. The temperature at which this condition is realized is the operating temperature. Theoretically, there should be a few fairly narrow weak bands still transmitted. If the red glass filters have not been used before, add them to the assembly to see that there are no unwanted transmission bands that they fail to eliminate.

The mounting of the filter described here is based on the author's apparatus pictured on page 148 of the April issue. The photograph reproduced here shows the unassembled mounting parts, and the large diagram gives a longitudinal cross-section. The instrument without the camera weights 18 pounds. The construction is entirely of brass and aluminum, with silver solder used at the points of greatest stress. The entire job can be done on a small lathe, except for the milling of the square cross-section of the filter box.

This box should allow for a slight expansion of the quartz, although usually the box material expands more rapidly than the crystal quartz, which is of the same order as glass in this respect. The heat conductivity of the box should be high so the heating lag is reduced. The inside of the box can be anodized black to reduce reflections off the sides. The box must also hold the immersion fluid. Soft Canada balsam is a good fluid as it will harden only around the edges from the gentle heating necessary in filter operation. Also, the balsam is too thick to flow from between the plates if their surfaces are not very flat. Glass filters larger than the quartz aperture can seal the ends of the filter box.

As mentioned last month, fine adjustments of the transmission bands are possible by arranging the thickest elements of quartz at opposite ends of the filter and adding a quarter-wave plate at each end. By rotating the two outer polaroids, the narrowest transmission bands can be shifted the distance of their spacing. If this technique is used, provision for rotating the end polaroids must be included.

Do not expect to observe any prominences until the filter has reached operating temperature. If with the finished instrument the prominences are seen better at the very edge of the field than at the center, the filter is cold. If it is too hot, the prominences and chromosphere do not show at all. These facts indicate the importance of heater design and operation. In my filter the temperature is controlled to ¼° centigrade. For a five-angstrom effective passband width, the internal temperature of the filter can fluctuate 0.7° centigrade. It is fairly easy to control the temperature within this range.

The upper right corner of the diagram shows the simple heater circuit, producing about 50 watts. Remembering that volts times amperes equals watts, we find that a 110-volt, 55-watt heater draws half an ampere. Since amperes times ohms equals volts, 220 ohms of resistance wire are needed. A resistance wire of about

The disassembled parts of the housing of Richard Dunn's monochromator.

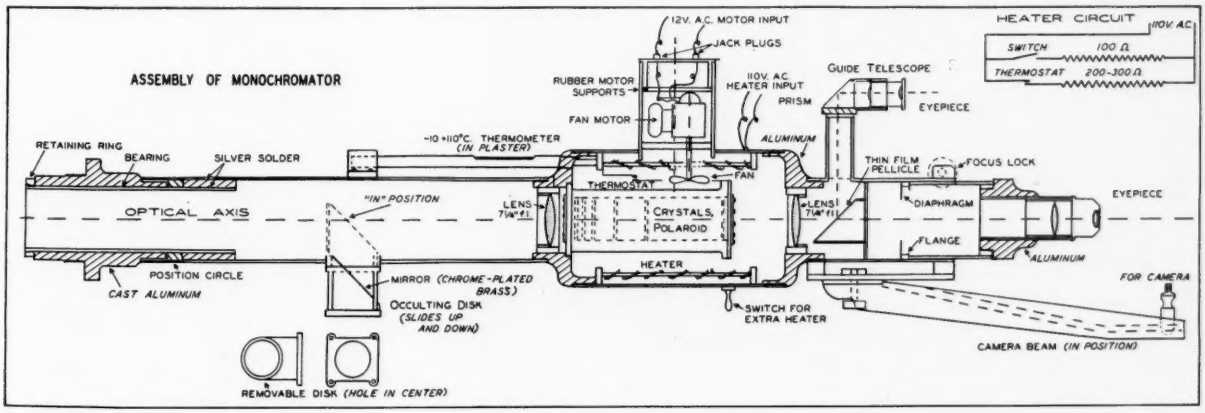
30 ohms per foot works effectively and should carry the 0.5-ampere current.

An alternative type of heater might consist of several small electric lights, totaling 50 watts. Suitable diaphragms could be used to eliminate their light from the optical parts of the filter. However, with full voltage they would probably burn out fast if close to each other.

A fan is almost a necessity to prevent stratification of air, especially if there is a large air space around the filter itself. A model train 12-volt motor drives the fan in my apparatus.

A bimetal strip will serve as a thermostat, although it closes slowly with much arcing if 0.5 ampere with 110 volts is used. Bimetals consisting of two metals fused together can be purchased, or a strip can be made by riveting two flat pieces of different metals together. A tungsten or silver contact should be fastened at the end of the strip.

Commercial thermostats are much better, and should be used if possible. For best temperature control in operation, the heater should be on as much as off. Resistance can be added or cut until this relationship is within reason. Of course, conditions change with the outside tem-



The general plan of the mounting of the filter, heat controls, and the beam for supporting the camera.

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perature. The heater is best built as a removable unit so that adjustments can be made easily.

An extra heater is useful to warm up the filter more quickly, though it must not get hot enough to harden the Canada balsam, nor so hot as to burn the filter out if this quick heater is left on. A second thermostat that opens at a much higher temperature could be added, and a pilot light with this circuit would be useful. The auxiliary heater can draw one ampere with 110 ohms of resistance.

The occulting disk greatly improves observing the prominences and the sun's chromosphere, and for filters of five angstroms passband it is a necessity. Its size is that of the sun's image, about 0.009 times the focal length of the telescope in inches. The author first measured the diameter of the sun's image with a steel scale and used that for his occulting disk size. Seasonal changes in the apparent semidiameter of the sun are given in the **American Ephemeris,** but the five-angstrom filter seems to be narrow enough to make it unnecessary to take this into account. Even though blackened, the occulting disk never gets too hot in spite of long use with Harvard's 15-inch, f/18 refractor.

The occulting disk should move in and out to accommodate prominences of different heights within the frame of the photographic film. If the occulting disk is built to pull out completely for observations of spots on the disk, the intensity of the sun's direct light should be cut down with infrared heat-absorbent glass, such as the Corning "Aklo" series. The polaroids do not polarize infrared light, so without this special filter glass a good deal of heat would be transmitted. In ordinary operation, the occulting disk excludes this direct sunlight, and avoids unwanted changes in the temperature of the filter. If the filter has a transmission band narrow enough to permit satisfactory observations of the sun's disk, the problem of solar heating and clouds becomes especially important. Generally speaking, the transmission band should not shift more than 1/10 its effective width through temperature change.

In order to view different areas of the sun's limb, the entire filter or the occulting disk alone must revolve around the axis of the telescope. In one arrangement, the filter is mounted off the axis of the telescope a distance equal to the radius of the sun. With this method, the limb can be scanned without moving the telescope in declination or right ascension.

If considerable photography is planned, and there is no reason why it should not be, provision should be made for guiding the telescope with the camera on the instrument. A 45° prism can slide into place to deflect the light to a guiding eyepiece, but it is better to mount a thin film or pellicle permanently because it deflects only a small part of the light. This method is described by E. Pettit in the **Publications** of the Astronomical Society of the Pacific, **54**, 41, 1942. The thin film can be made with the material commonly used to cover the wings of featherweight model planes. Directions for making the film are on the bottle. With the single-lens reflex camera used by the author,

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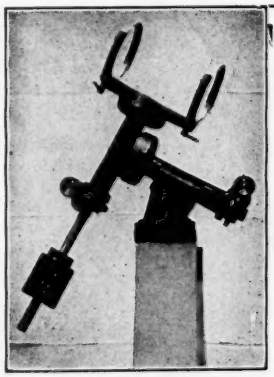

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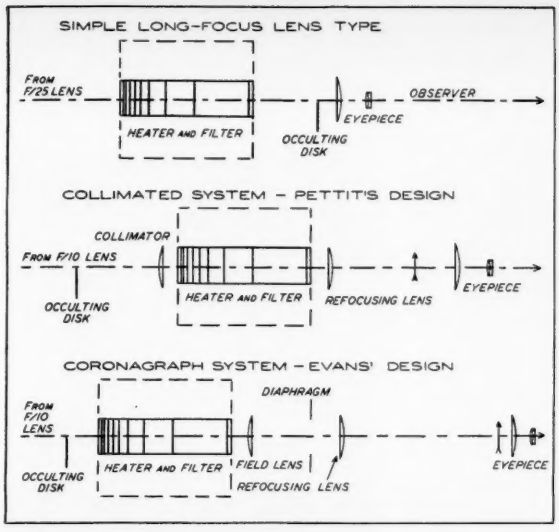

The three optical systems in which the filter can be used, depending upon the nature of the telescope objective and upon the need to minimize scattered light or to minimize imperfections in the elements of the filter.

guiding can be done directly until exposure time, and therefore the pellicle has never been used.

The whole apparatus should not only be built rigidly enough to support the camera equipment, but since the filter mounting is a long extension to the telescope, the observer should be able to move the telescope by pushing on the filter housing.

Three optical systems used with the filter are illustrated here. In the simplest system the filter is placed in front of the image formed by the telescope objective, which must have a long focus (f/25 or more). The long focus prevents the filter from heating up too much and partially overcomes the fact that the light is not collimated. A single non-achromatic lens can be used for the telescope objective. Imperfections in the quartz and polaroid tend to scatter more light than if the occulting disk were ahead of the filter, simply because more light is involved.

To move the filter behind the occulting disk and to gain the advantage of well-collimated light, Pettit's arrangement may be used. The surfaces of the filter elements have to be somewhat flatter, as they have a greater effect on the final image.

The coronagraph system is probably the best, as it eliminates more scattered light than the other arrangements. It does, however, use the filter in a slightly more converging beam than the collimated system.

In all these arrangements, provision must be made for focusing the eyepiece on the occulting disk, and for getting the disk into the plane of the image to eliminate any parallax between the solar image and the occulting disk. The lenses used should preferably be simple rather than achromatic, although mine were war-surplus achromats. Achromatic elements and objective should be red- or green-corrected as in a visual instrument. Photographic blue lenses have excessive spherical aberration in the red. Anti-reflection coatings help little if they are designed for greatest efficiency in the green rather than in the red.

Our concluding discussion next month will stress techniques of prominence photography.

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

VISUAL OBSERVING PROGRAMS FOR AMATEURS — XVIII

Observing the Moon and Planets

MY OWN experience in this regard has been about that of most amateurs. I have looked at the crescentiform Venus, tried to observe Mercury without much avail, located Uranus and Neptune just to say that "I have seen them," watched some of the phenomena of Jupiter's satellites, and spent some time studying Saturn's rings. I have followed the brightnesses of Vesta and Amphitrite at times of opposition in an effort to determine their periods of rotation, spent many evenings trying to discern the markings on Mars, and tried to look for meteor flashes on the moon at the time of eclipse, only to be clouded out.

I did not feel that this limited experience had qualified me to write an authoritative article on observing the moon and planets, which is one of the more difficult fields for amateurs, but fortunately Walter H. Haas came to my rescue.

Mr. Haas, who lives at 1203 N. Alameda St., Las Cruces, N. M., is the director of the Association of Lunar and Planetary Observers (ALPO), the foremost group in the Western Hemisphere devoted to promoting this work by amateurs. During a recent visit to the East, Mr. Haas found time to spend a weekend with me discussing the problems of amateur observers. What I now pass on to you consists largely of what I gleaned from him upon this subject, but it must not be considered as being more than an introduction. The **Strolling Astronomer,** which is sent to members of the ALPO, and the publications of the British Astronomical Association should be consulted for more detailed information.

Walter H. Haas, director of the Association of Lunar and Planetary Observers.

General Instructions. Training the eye is important. Those who have used a microscope know that the eye becomes more proficient with experience. Don't expect to see a score of canals on Mars the first time you look at it!

Keep a notebook or log even if you don't see anything sensational. The time may come when you will have to refer back to your old records to determine the date of some dramatic and at present unforeseeable event. The information entered should include the date, the year, and the time (designating the system used, for instance, EST or UT). The observer's geographical location, size and kind of telescope, type of eyepiece, focal length and power, should be recorded. Any peculiarities of the technique of observing should be jotted down, such as the use of filters, and some evaluation should be given as to whether the observation is good, uncertain, or poor. The seeing (S) and transparency (T) should be recorded.

There is a difference between seeing and transparency. When the atmosphere is transparent very faint stars can be seen, but they may be unsteady and twinkling, as they often are in the clear air of a cold wave following in the wake of a storm. Steady seeing may, and often does

R. A. Stolle, of Los Angeles, and the 10-inch f/11.2 reflector built by him and his son, Mark Allen Stolle. The 215-pound mounting and telescope can be removed from the automobile and set up by two persons in seven minutes. The clock drive is electrical, and can use 6-volt current if necessary. This is an ideal instrument for planetary observing.

occur when there is some haze in the air and the atmosphere is not especially transparent. Seeing is reported on a scale of 1 (worst) to 10 (best), and transparency on a scale of 1 to 5, where 5 is the best and 1 is probably hopelessly poor. Thus S7T3 means considerably better than usual steadiness and only average transparency.

To do any useful work on the moon and planets, one must have good observing conditions. If it is too windy, an outdoor telescope will shake badly. If the seeing is poor, the image will be unsteady in the telescope. If the transparency is low, the image will not be as bright as usual, but this is less of a handicap than poor seeing.

It is advantageous to prepare outline sketches of Mars, Jupiter, and especially Saturn, before going to the telescope. The **American Ephemeris** gives data on the rings of Saturn which will enable you to determine their ellipticity so as to make an accurate outline in advance. If drawings are made, draw them at the telescope and don't touch them up later to make them agree with standard maps. Maybe Syrtis Major was fainter than Mare Acidalium or Utopia when you were observing Mars, instead of being more distinct, as it usually is.

New observers should send their observations to Mr. Haas for his advice and suggestions. Later he may refer you to various section leaders of the ALPO.

Refer to the accompanying table of recommended powers and apertures when you start observing, say, the markings on Mars or a crater on the moon. The figures 100 x 4 mean 100 power, 4-inch aperture. In general, use 25x per inch of aperture as a minimum and up to 40x or 50x per inch of aperture if better results are obtained with higher powers. Larger telescopes possess greater resolving power and also the greater light grasp required if high magnifications are being used. Larger instruments are said to suffer more from poor seeing than do small instruments, and for amateurs they are costly and perhaps unwieldy. Nevertheless, 10-, 12-, and 16-inch telescopes will show details on Mars that 6-inch instruments will not reveal.

RECOMMENDED POWERS AND APERTURES IN INCHES

Object	Minimum power and aperture	For better views use
Jupiter — transits and sketches	100 x 4	150 x 6
satellite markings	300 x 12	450 x 12
Saturn	150 x 6	8″-12″ aperture
Mars — coarse markings	100 x 4	180 x 6
finer details	180 x 6	Large aperture
Venus	80 x 3	150 x 6
Mercury	120 x 3	200 x 6
Uranus — sketches	200 x 10	300 x 12
magnitude estimates	Low-power binoc.	Low-power binoc.
Neptune and asteroids — magnitude estimates	Large binocular	Small refractor, low power, wide field
Moon — search for meteors	100 x 6	10″-15″ aperture
crater changes	150 x 6	8″-10″ aperture

As we all know, neither the planets nor the moon are always suitably placed for study, so that we must observe them when we can. The programs tabulated are arranged approximately in the order in which a neophyte like myself should tackle them. An exception may perhaps be made of the brightnesses of Uranus, Neptune, and the asteroids, which can usefully be undertaken at any apparition by a person trained in variable star work. The moon will be dealt with after we have considered the planets. This does not imply that it should be left until last. Indeed, it could well be undertaken before doing planetary work.

DAVID W. ROSEBRUGH
79 Waterville St.
Waterbury 10, Conn.

THE AURORA OF JULY FIRST

THE AURORA on the night of July 1-2 was widely observed over the northeastern part of the country. The display reached its maximum about midnight, with pronounced activity in the zenith. Arden J. Hartzler reported from Hummelstown, Pa., that until midnight the northern lights were rather diffuse, with the exception of two horizon-to-horizon bands flickering near the zenith, and slight traces of rays. Then, shortly after 12:00, "spraying" over fully a quarter of the sky, the rays became definite, bright, and with varying colors near the zenith, this phase lasting for about five minutes. By 1:00 a.m. the aurora had faded so it could not be seen.

From Gloucester, N. J., only two miles from Philadelphia, John F. Bicking took a series of photographs, one of which is reproduced here. He first saw bright patches of auroral light at about 11:15, one in the northwest and one in the northeast. These masses gradually formed slow-moving, ill-defined rays. At 11:45 the display seemed near an end, he writes, but at 11:49 an arc appeared about 15 degrees high and began moving toward the zenith. The growing brightness took on a brilliant apple-green color. The arc reached five degrees south of the zenith, at which time the southern edge was well defined. In the north a double drapery had formed, also apple green. Three minutes afterward the arc took on a flaming appearance. This activity lasted until 11:54, when a brilliant corona appeared at the southern limit of the zenith arc. Four minutes later the corona was nearly invisible, and the display was over in about a quarter of an hour.

Observations were also made by a group in Danbury, Conn., as reported by Henry William White. Here, too, the most pronounced activity was in the zenith. Edwin V. Greenwood wrote from Toronto, Ontario, that the maximum activity was around midnight, the curtain effect was very noticeable, and that the changes in the form of the aurora seemed much slower than in the display seen by him in August, 1950. "Considering that we are approaching a sunspot minimum," he said, "the two displays seen in the last year have been most spectacular."

The auroral corona, 30-second exposure at f/4.5. Photo by John F. Bicking.

DEEP-SKY WONDERS

SIR WILLIAM HERSCHEL, the greatest observer of nebulae, arranged the vast majority in his catalogue in three classes of brightness. Some special nebulae and clusters were distributed into five other categories. In class I, which contained 288 objects, he placed "bright" nebulae. A survey of this class shows magnitudes ranging from 10.5 to less than 13.0, with a pretty well-defined average at 12.3. In other words, the amateur should expect to find the average class I nebula at about that brightness. Class II, which contains 910 objects, is called "faint," with magnitudes from 11.8 to fainter than 13.0, and the average at 13.0 itself. Class III, with 985 objects, is usually beyond amateur instruments, with only a few brighter than 13.0.

But for the really small instrument this month, we suggest NGC 7009, 14, $21^h\ 1^m.5$, −11° 34′, a bright 8th-magnitude planetary just preceding Nu Aquarii. Two thin rays that can be seen under exceptional conditions give it the name "Saturn nebula." Nearby and easy are the globular cluster NGC 6981, M72, $20^h\ 50^m.7$, −12° 44′, diameter 5′; and the galactic cluster NGC 6994, M73, about a degree eastward, hardly more than a few random stars. Although the three are in Aquarius, older writers usually include the latter two in Capricornus, under which designation one must look for their descriptions.

WALTER SCOTT HOUSTON

VARIABLE STAR MAXIMA

September 3, R Centauri, 5.9, 140959; 4, S Carinae, 5.7, 100661; 4, R Virginis, 6.9, 123307; 5, X Monocerotis, 7.6, 065208; 8, R Leporis, 6.7, 045514; 8, U Ceti, 7.5, 022813; 11, R Leonis, 5.9, 094211; 15, R Aquarii, 7.3, 233815; 18, SS Virginis, 6.9, 122001; 22, R Reticuli, 7.7, 043263. October 6, T Centauri, 6.1, 133633.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

MINIMA OF ALGOL

September 1, 16:56; 4, 13:45; 7, 10:33; 10, 7:22; 13, 4:11; 16, 0:59; 18, 21:48; 21, 18:36; 24, 15:25; 27, 12:14; 30, 9:02. October 3, 5:51; 6, 2:40; 8, 23:28.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See **Sky and Telescope**, Vol. VII, page 260, August, 1948, for further explanation.

PREDICTIONS OF BRIGHT ASTEROID POSITIONS

Eukrate, 247, 9.7. Sept. 11, 0:54.7 +8-36; 21, 0:43.3 +10-09. Oct. 1, 0:29.6 +11-32; 11, 0:15.3 +12-45; 21, 0:02.0 +13-47; 31, 23:51.3 +14-39.

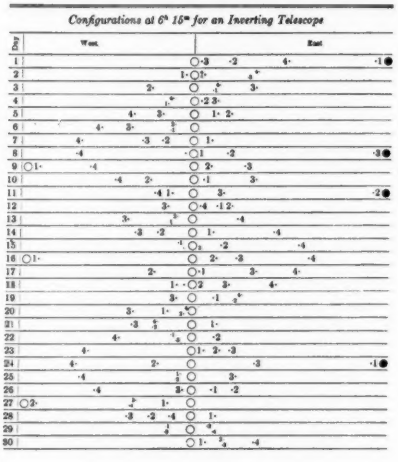
Hertha, 135, 9.5. Sept. 11, 1:11.3 +9-08; 21, 1:04.6 +8-49. Oct. 1, 0:55.9 +8-14; 11, 0:46.6 +7-30; 21, 0:38.0 +6-46; 31, 0:31.6 +6-11.

Polyhymnia, 33, 9.5. Sept. 11, 0:49.0 +4-31; 21, 0:43.5 +4-20. Oct. 1, 0:36.4 +3-55; 11, 0:29.2 +3-27; 21, 0:23.3 +3-06; 31, 0:20.0 +2-59.

After the asteroid's name is its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1951.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the **American Ephemeris and Nautical Almanac.**



UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

THE INDEX TO VOLUME X

of **Sky and Telescope** will be included in the October, 1951, issue. It will be abbreviated in form compared with former indexes, but all subscribers will receive it without extra charge. The index may be removed from the issue for binding at the front or back of a complete 1950-1951 volume.

The more detailed, cross-referenced indexes to Volumes I through IX are still available, postpaid for 35 cents each, in coin or stamps.

SKY PUBLISHING CORPORATION
Cambridge 38, Mass.

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.
SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 14, Mass. Richmond 2-1410.
SCHEDULE: Tuesday through Friday, 3 and 4 p.m.; Saturday, 11 a.m., 2, 3, and 4 p.m.; Sunday, 2, 3, and 4 p.m. Spitz projector. In charge, John Patterson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.
SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.
SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Manager, A. F. Jenzano.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.
SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.
SCHEDULE: Wednesday and Saturday, 3:30 p.m.; Sunday, 3:00 and 5:00 p.m. Spitz projector. Director, Charles G. Wilder.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.
SCHEDULE: Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.
SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Chairman, Robert R. Coles.

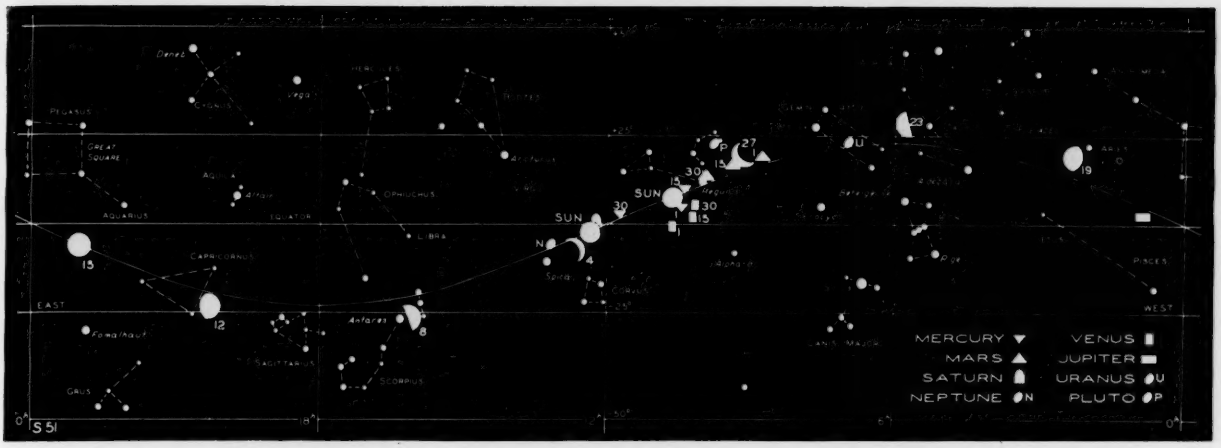
PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.
SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.
SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium.* 908 N.E. Hassalo St., Portland 12, Ore., East 3807.
SCHEDULE: Saturday, Sunday, and Wednesday, 4:00 p.m.; Tuesday, Thursday, and Friday, 8:00 p.m.; Saturday show for children only, 10:30 a.m. Spitz projector. Director, Stanley H. Shirk.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.
SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.
SCHEDULE: Sunday, 4:15 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

The sun on September 1st will be in annular eclipse, visible as annular or partial from the eastern United States and Canada shortly after sunrise. For details, see the four previous issues of **Sky and Telescope.**

Mercury enters the morning sky on August 31st and remains there through October 13th. Greatest elongation will be attained on September 16th, 17° 53′ west of the sun. Although this distance is quite small, Mercury will be well north of the sun, rising 1½ hours before it, easily discernible for it will be of zero magnitude. By the end of the month Mercury will have brightened by a magnitude, and will rise one hour before the sun.

Venus passes inferior conjunction with the sun on September 3rd, moving into the morning sky. At conjunction, the planet is 8° 38′ south of the sun and may be viewed during the day with good binoculars or a telescope. Venus is then a narrow crescent 59″ in diameter, with only 1.1 per cent of the disk illuminated. About a week later the planet becomes visible to early risers, in the morning sky. The crescent remains small, but as the illuminated portion increases the planet rapidly gains in brilliance. At the end of September Venus will appear 2½ hours before sunrise and be of −4.2 magnitude.

Earth will attain heliocentric longitude 0° on September 23rd at 20:38 UT. Autumn commences north of the equator and spring in southern latitudes.

Mars rises three hours before the sun in the morning sky, but it is not conspicuous for it is 2nd magnitude. Mars is moving eastward in Cancer and Leo and is of little interest at this time.

Jupiter, a prominent object this autumn, will be observable most of the night. Appearing above the eastern horizon shortly after sunset, Jupiter far outshines all the stars, at magnitude −2.5. Opposition with the sun occurs October 3rd. The Jovian disk is 49″ in diameter at the equator, discernible with field glasses.

Saturn leaves the evening sky on September 29th, passing conjunction with the sun.

Uranus, visible with slight optical aid the latter half of the night, is moving slowly eastward about 2° north of Zeta Geminorum.

Neptune will be in proximity to the sun in the evening sky and not visible.

E. O.

PHASES OF THE MOON

New moon	September	1, 12:49
First quarter	September	8, 18:16
Full moon	September	15, 12:38
Last quarter	September	23, 4:13
New moon	October	1, 1:57

		Distance	Diameter
September			
Perigee	11, 20h	228,200 mi.	32′ 33″
Apogee	23, 21h	251,200 mi.	29′ 33″
October			
Perigee	7, 7h	229,900 mi.	32′ 18″

OCCULTATION PREDICTIONS

September 13-14 **Sigma Aquarii** 4.9, 22:28.1 −10-55.8, 13, Im: **G** 7:42.2 −1.4 −0.3 76; **H** 7:36.3 −3.1 −0.9 102; **I** 7:29.5 −1.4 +0.5 65. Em: **H** 8:22.6 +0.3 +2.7 178.

September 16-17 **Delta Piscium** 4.6, 0:46.1 +7-19.1, 16, Im: **A** 1:33.8 −0.3 +2.0 43; **C** 1:25.6 −0.2 +2.0 44. Em: **A** 2:37.3 −0.9 +1.7 247; **B** 2:41.2 −0.9 +1.7 252; **C** 2:27.1 −0.8 +1.7 248; **D** 2:33.1 −0.8 +1.7 257.

September 27-28 **Rho Leonis** 3.8, 10:30.2 +9-33.6, 27, Im: **H** 14:05.3 −0.9 −0.7 139. Em: **H** 15:16.9 −1.6 +0.4 284.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the American Ephemeris and the British Nautical Almanac are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +31°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

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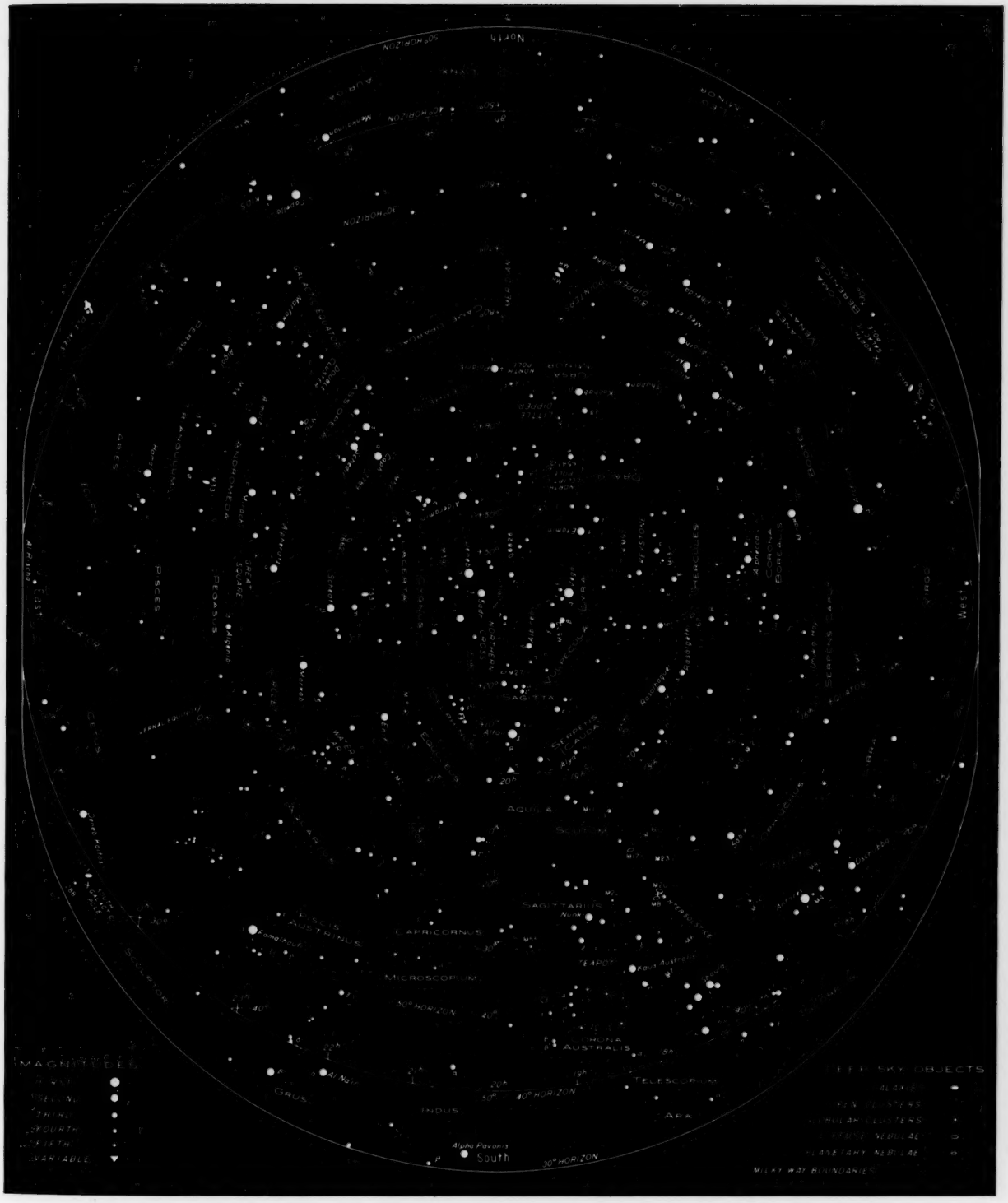
ALABAMA	Gadsden	Ala. A.A.	7:30, 1st Thu.	Ala. Power Audit.	Brent L. Harrell, 1176W or 55
ARIZONA	Phoenix	*Phoenix Obs. Ass'n.	8:00, 1st, 3rd Tue.	Phoenix College	Paul E. Griffin, 1708 S. 3rd St.
CALIFORNIA	Kentfield	*Marin Am. Ast.	8:00, 4th Fri.	Marin College	Mrs. I. Osborn, 223 Santa Margarita, San Rafael
	Los Angeles	L.A.A.S.	7:45, 2nd Tue.	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club	7:00, Thu.	Excelsior Union H.S.	Geo. F. Joyner, 12008 E. Sproul St.
	Oakland	*Eastbay A.S.	8:00, 1st Sat.	Chabot Obs.	Miss A. Roemer, 1556 Everett, Alameda
	Palo Alto	*Peninsula A.S.	7:30, 1st Fri.	Community Center	H. W. Milner, 350 Tennyson Ave.
	Sacramento	*Sac. Val. A.S.	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. E. Champ, 3816 Sacramento Blvd. (17)
	San Diego	Ast. Soc. of S.D.	7:30, 1st Fri.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	A.T.M. Ast. Club	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, Bayview 3757
	Stockton	*Stockton A.S.	8:00, 2nd Mon.	Stockton College, P-11	W. A. Craig, 1043 W. Park
COLORADO	Denver	†*Denver A.S.	8:00, 2nd, 4th Mon.	Chamberlin Obs.	W. E. Johnson, 264 S. Gilpin St. (9)
CONNECTICUT	Middletown	*Centr. Conn. A.A.	8:00, 1st Tue.	Van Vleck Obs.	Walter Fellows, Middle Haddam
	New Haven	†A.S. of New Haven	8:00, 4th Sat.	320 York St.	Mrs. Helen Velardi, 437 Wash., N'th Haven
	Norwalk	Norwalk A.S.	8:00, Last Fri.	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
	Stamford	Stam. Museum A.A.	8:00, 3rd Fri.	Stamford Museum	R. F. Ives, Post Rd. East, Darien
DIST. COL.	Washington	†Nat'l. Cap. Ast'mers	8:00, 1st Sat.	Comm. Dept. Audit.	Janet Perkins, 2141 Eye St. NW (7), RE 7676
FLORIDA	Daytona Beach	D. B. Stargazers	8:00, Alt. Mon.	105 N. Halifax Ave.	Wm. T. Thomas, 105 N. Halifax
	Jacksonville	*J.A.A.C.	8:00, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†Key West A.C.	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	South'n Cross A.S.	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
GEORGIA	Atlanta	†*Atlanta A.C.	7:30, 2nd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
ILLINOIS	Chicago	†*Burnham A.S.	4:00, 2nd Sun.	Adler Planetarium	Wm. Callum, 1435 Winona St.
	Geneva	*Fox Valley A.S.	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 501 S. 6th St., St. Charles
	Moline	†*Popular A.C.	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
INDIANA	Indianapolis	†Indiana A.S.	2:15, 1st Sun.	Riley Library	Clark B. Hicks, 305 Ruckle St.
KANSAS	Topeka	*Topeka A.A.S.	7:30, 2nd Mon.	Topeka H.S.	Miss N. Utschen, 1607 Wayne Ave.
	Wichita	†*Wichita A.S.	8:00, 1st Wed.	.....	Dollie Ratcliff, 801 Maple, 2-1822
KENTUCKY	Louisville	†L'ville A.S.	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 621 34th St.
LOUISIANA	New Orleans	A.S. of N.O.	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†A.S. of Maine	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†*Bond A.C.	8:15, 1st Thu.	Harvard Obs.	C. A. Federer, Jr., Harvard Observatory
	Cambridge	†*A.T.M.s of Boston	8:00, 2nd Thu.	Harvard Obs.	H. Smith, 26 Kingman St., Weymouth, 9-3438-R
	Springfield	†*S'field Stars	8:00, 2nd Wed.	Private homes	F. D. Korkosz, Mus. Nat. Hist., 2-4317
	Worcester	†*Aldrich A.S.	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	Ralph A. Wright, 4 Mason St.
MICHIGAN	Ann Arbor	†Ann Arbor A.A.A.	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†B. C. A.A. Club	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†*Detroit A.S.	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Detroit	†*N.W. Detroit A.S.	8:00, 1st Tue.	Redford H. S.	John W. Broxholm, 16596 Chapel St. (19)
	Kalamazoo	†Kalamazoo A.A.A.	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	†*Lansing A.A.	8:00, 1st, 3rd Wed.	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St. (14)
	Pontiac	†*Pontiac A.A.A.	8:00, 3rd Sun.	Cranbrook Inst.	Mrs. M. Chircop, 147 Prospect St., 21455
MINNESOTA	Duluth	†*Darling A.C.	8:00, 1st, 3rd Fri.	Darling Obs.	Mrs. A. Lynch, 1911 Wisconsin, Superior, Wis.
	Minneapolis	M'polis A.C.	7:30, 1st, 3rd Wed.	Public Library	Jane Simmer, 2406 Clinton Ave. S.
	St. Paul	*St. Paul Tel. Club	7:30, 2nd, 4th Wed.	Macalester Coll.	Mrs. H. Wolcott, 1705 Scheffer Ave. (5)
MISSOURI	Fayette	†*Central Mo. A.A.	7:30, Last Sat.	Morrison Obs.	R. C. Maag, 611 Bluff St., Fulton
	Kansas City	†*A.A. & T.M.s	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	†*St. Louis A.A.S.	8:00, 3rd or 4th Sat.	Inst. of Tech., St. L. U.	S. O'Byrne, 501 E. Pacific, Webster Groves 19
NEVADA	Reno	A.S. of Nev.	8:00, 4th Wed.	Univ. of Nevada	E. W. Harris, University of Nevada
NEW JERSEY	Caldwell	West Essex A.A.	8:00, 2nd Mon.	Caldwell Mun. Bldg.	D. C. Smith, 19 Francisco Ave., W. Caldwell
	Jersey City	†Revere Boys Club	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Roselle Park	†A.A.S. of Union Co.	...., 4th Fri.	Boro Hall	Mrs. R. N. Bochau, 236 Normandy Vill., Union
	Teaneck	†Bergen Co. A.S.	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW YORK	Buffalo	†*A.T.M.s & Observers	7:30, 1st, 3rd Wed.	Mus. of Science	Dr. F. S. Jones, 83 Briarcliffe, Cheektowaga
	Gloversville	†A.C. of Fulton Co.	....	.....	L. R. Ogden, 60 W. Pine St.
	New York	*A.A.A.	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., TR 3-1300
	New York	†Junior A.C.	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., TR 3-1300
	Rochester	†Rochester A.C.	8:00, Alt. Fri.	Rochester Museum	H. O. Woodard, 485 Hayward Ave. (9)
	Schenectady	†*S'tady A.C.	8:00, 2nd Mon.	Schenectady Museum	C. E. Johnson, 102 State St.
	Troy	*Renss. Ap. Soc.	7:30, Alt. Tue.	Sage Lab., R.P.I.	S. J. Lukasik, 31 Belle Ave.
	Utica	†*Utica A.A.S.	7:30, 4th Tue.	Proctor Inst.	John Zimm, 239 Thieme Pl.
	Wantagh	Long Island A.S.	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	†*Greensboro A.C.	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Z. V. Conyers, 210 W. Fisher Ave.
	Raleigh	†Astronomical Soc.	....	N. C. State Coll.	C. F. Campen, Jr., Physics Dept.
	Winston-Salem	†*Forsyth A.S.	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
OHIO	Akron	*A.C. of Akron	8:00, 2nd Fri.	Beth.-Luth. Church	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	*Cin. A.A.	8:00, Various days	Cincinnati Obs.	Robert Berkmeier, 2432 Ohio Ave.
	Cincinnati	*Cin. A.S.	8:00, 3rd Wed.	5556 Raceview Ave.	John Dann, 3318 Felicity Dr. (11)
	Cleveland	†Cleveland A.S.	8:00, Fri.	Warner & Swasey Obs.	Mrs. A. Townhill, Warner & Swasey Obs.
	Columbus	*Columbus A.S.	8:00, 2nd Fri.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	A.T.M.s of Dayton	Eve., 3rd Sat.	Private homes	F. E. Sutter, RR 7, Box 253A (9)
	Lorain-Elyria	*Black River A.S.	8:00, 2nd Mon.	Clearview School	Louis Rick, Box 231, Lorain
	Marietta	Marietta A.S.	Irregular	Cisler Terrace	Miss L. E. Cisler, Cisler Terrace
	Toledo	Toledo Ast. Club	...., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	Mahoning Val. A.S.	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	*Y'town A.C.	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OREGON	Portland	†*Portland A.S.	8:00, 1st Mon.	Planetarium	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	†A.T.M. & Observers	8:00, 2nd Tue.	Mus. of Sci. and Ind.	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	†*Beaver Co. A.A.A.	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Millvale	A.A.A. Shaler T'ship	8:00, 3rd Fri.	Cherry City Fire House	Cliff Raible, Rebecca Sq. (9)
	Philadelphia	†A.A. of F.I.	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, RIT 3050
	Philadelphia	*Rittenhouse A.S.	8:00, 2nd Fri.	Morgan Physics, U. Pa.	Sarah Lippincott, Sproul Obs., Swarthmore
	Pittsburgh	†*A.A.A. of P'burgh	8:00, 2nd Fri.	Buhl Planetarium	G. Winterhalter, 5-J Terrace, McKees Rocks
RHODE ISLAND	Providence	Skyscrapers, Inc.	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., Jackson 1-5680
S. CAROLINA	Columbia	North'n Cross A.S.	8:15, Every Mon.	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
TENNESSEE	Chattanooga	*Barnard A.S.	8:00, 3rd Fri.	Jones Observatory	C. T. Jones, 1102 James Bldg., 7-1936
	Nashville	*Barnard A.S.	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Dallas	†Texas A.S.	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, U6-3894
	Ft. Worth	†*Ft. Worth A.S.	8:00, 4th Fri.	Texas Christian U.	L. C. Eastland, 5501 Byers Ave. (7)
	Houston	Houston A.S.	7:30, Last Fri.	Mus. Nat. Hist. Annex	Mrs. J. Murray, 1007 W. Gray (6)
	Port Arthur	†*Port Arthur A.C.	...., 2nd Tue.	Private homes	G. van den Berg, Box 266, Groves
UTAH	Salt Lake City	†*A.S. of Utah	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	Springfield T.M.s	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	†*A.A.S. of Norfolk	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
	Richmond	†*Richmond A.S.	8:00, 1st Tue.	Builders Exchange	Miss L. Sievers, 4018 Clinton Ave. (27)
WASHINGTON	Spokane	*A.T.M.s of Spokane	....	.....	D. K. Johnson, 301 S. 15th, Coeur d'Alene, Id.
	Tacoma	Tacoma A.A.	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	†*Yak. Am. Ast'mers	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Beloit	Beloit A.S.	...., 1st, 3rd Thu.	YMCA Bldg.	Kenneth W. Schultz, 959 Johnson St.
	Madison	†Madison A.S.	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†*Milw. A.S.	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis



The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of September, respectively.

STARS FOR SEPTEMBER

EQUULEUS, the Little Horse, noses out a near neighbor in the September sky, Sagitta, the Arrow, for being the smallest constellation in the heavens. No wonder most amateurs have to consult a chart to find Equuleus. Composed of three 4th-magnitude stars, the Little Horse is sandwiched between a larger steed, Pegasus, and Delphinus.

On the meridian for the time of our chart is Sagitta, the Arrow, an almost equally neglected constellation. Only Equuleus and the southern hemisphere's Crux are smaller. Sagitta, however, boasts a 3rd-magnitude star in addition to three 4th-magnitude stars.

A newer constellation, fabricated by Hevelius, lies just north of Sagitta. Vulpecula, the Fox, slinks across the width of the Milky Way, but has even fainter stars than its smaller neighbor, Sagitta.

Even Lyra, well placed in the September evening sky, seems spacious compared to these lesser combinations. With the brilliant sweep of sky from Altair to Vega and Deneb, the Little Horse, the Arrow, and the Fox almost fade into obscurity.

CHART CORRECTION: In this chart the Greek letters for Alpha and Beta Cassiopeiae should be exchanged.